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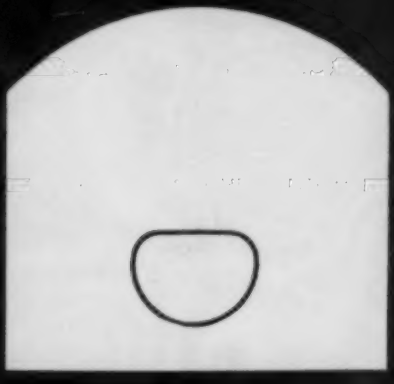

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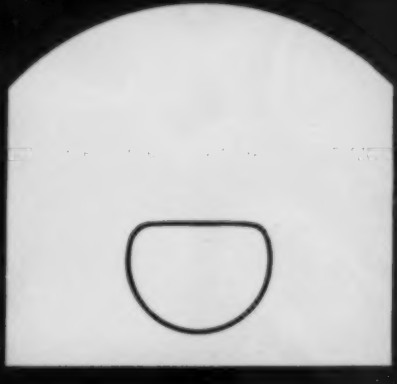

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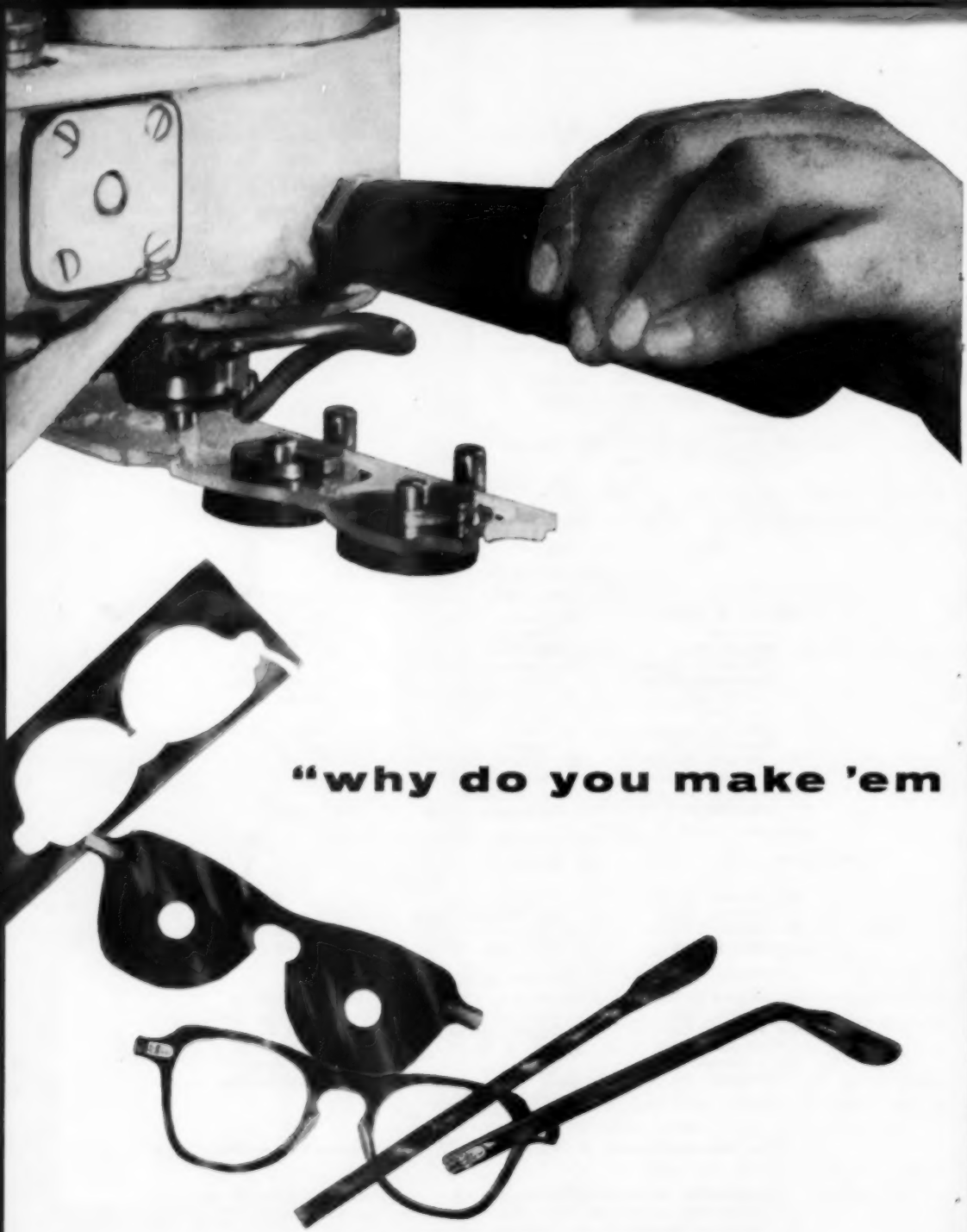

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PSYCHOPHYSIOLOGICAL ASPECTS OF THREE DIMENSION MOTION PICTURES*

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With the advent of three dimension motion pictures, many physiological and psychological problems have arisen. It is interesting to note that at least one author, Mathews,[1] states that the appeal and acceptance by the public of the new type of motion picture may be explained upon a psychological basis. He states that television confines "socially minded people night after night to the limits of their living room . . ., restricting their attention to the small area of a miniature picture." Three dimension movies, Mathews concludes, owe their success to the psychological desirability of the broad scope of the picture as opposed to the limited tiny television picture.

The increased scope is at present achieved in the following three different ways:

1. By means of a screen larger than that used in the past.
2. By means of dual images and stereopsis which increases perceived space in the dimension perpendicular to the screen.
3. By presenting different aural stimuli through speakers in widely separated parts of the theater, a procedure known as stereophonic sound.

These methods of creating an illusion of spaciousness have already been described in the optometric press[2, 3, 4, 5, 6] and require no further consideration here.

In the development of three dimension motion pictures, attention has been mainly directed towards the technological aspects, while physiological and psychological problems were neglected. Now, it is generally agreed, the time has come to solve these problems. This,

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however, is not easily nor immediately accomplished. Practical problems often cannot be solved until certain theoretical concepts have been developed. In 1947 we called attention to a similar situation, interestingly enough involving the same theoretical material, with regard to depth perception as it applied to aviation. Hirsch[7] stated, "The four years during which the author has conducted the research reported in this thesis have shown him the great need for fundamental research, which usually cannot be conducted while the war effort is demanding immediate results of a practical nature."

To be sure, a great body of basic research is available, but it is not enough. As the authors considered the psychophysiological problems which must be solved if three dimension movie-goers are to be assured of optimal visual conditions, they were aware of a number of practical problems whose solutions will have to await further basic research.

The scope of the present paper may now be stated. It contains a consideration of one psychophysiological problem which at present is of major concern to the motion picture industry, namely, that of illumination. This problem was chosen for more complete exposition because of its immediate importance, but also because the authors have in the past gathered theoretical data which may be used in solving this problem. The illumination question illustrates nicely how basic research data may be applied to help solve a problem of a practical nature. A few of the other psychophysiological problems encountered in three dimension movies will be mentioned. These and similar ones must be solved by some combination of analysis of known principles and additional basic and applied research.

THE EFFECT OF ILLUMINATION ON THE DISTANCE DISCRIMINATION THRESHOLD

The sensitivity of distance discrimination, like visual acuity, increases with illumination.[8] Since the polarizing filters and the viewing spectacles used in 3-D movies materially reduce illumination, it should be clear that the sensitivity of distance discrimination may fall to an undesirably low level. The following exposition is an attempt, based upon earlier experimentation,[9] to determine the effect upon depth perception of illumination levels currently used in motion picture projection.

The apparatus used was built according to the description of Howard.[10] The subject observed through a window 20 cm. wide and 12 cm. high the central sections of two dull, black, vertical rods, 1 cm. in diameter and 6 cm. apart laterally. The background, a sheet of dull, white cardboard, was 55 cm. behind the window. The rod on

the observer's left was fixed half way between the window and the background, while that on his right could be moved forward or backward, its position being indicated on a meter scale. The apparatus was illuminated by indirect light from the white background, while the partition containing the window was illuminated to the same level as the background. The window was exposed once every 4 seconds for a period of 0.25 seconds by a shutter. This consisted of two fiber board disks 120 cm. in diameter, each having an open sector of 90° and each being fixed to a motor-driven shaft. One disk had a rate of 60 r. p. m., while the other had a rate of 15 r. p. m. The disks were painted the same dull white as the partition, and the brightness of the shutter was matched to that of the partition and that of the background for each level of illumination.

The illumination levels used were .00025, .0025, .025, 0.25, 2.5, and 25 millilamberts. Fourteen students in an elementary psychology class at Stanford University served as subjects. The distance discrimination threshold for each suject was measured at each of the six illumination levels. The constant method of stimulus presentation was used, and answers were forced into one of two categories, "near" or "far." Five stations or rod separations were used, each being presented 60 times for each illumination level: the results of the 300 answers were analyzed by the probit method. The root mean square error, a measure of dispersion closely related to the standard deviation, was adopted as the threshold. This measure is described more fully in our original report[9] and by Woodworth.[11]

Because of the great range of thresholds encountered with the variation in illuminance used and the physical limitation of the size of the test apparatus, it was not possible to make all of the observations at the same test distance. In order to combine these results, one group was tested at various observation distances, a conversion equation obtained, and the observations transformed to a calculated 6 meters. This procedure is not wholly satisfactory, but the general consistency of the results and their appropriateness to the present problem leads us to present certain general findings as a first approximation.

The average thresholds for the 14 subjects at the six illumination levels are presented as Figure 1. It will be seen that the threshold rises from a value of about 65 mm. at an illumination of 25 millilamberts to a level of about 470 mm. at the lowest illumination.

The four highest illumination levels are those of importance to the present problem. The illumination of the movie screen will seldom, it is hoped, fall below .025 millilamberts. To facilitate use of the results

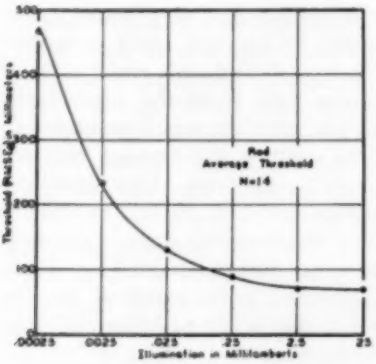

Fig. 1

in the present problem, a table has been prepared showing the illuminance corresponding to different threshold increases (or sensitivity decreases). The curve presented in Figure 1 becomes asymptotic at a level of 61 mm. This is the minimum threshold (maximum sensitivity) under these conditions for any illumination. A threshold of 67.1 mm. would, then, represent a 10 per cent increase (or a 10 per cent decrease in sensitivity), and a threshold of 122 mm. would correspond to a sensitivity decrease of 100 per cent. The percentages in the following tables are such figures, and the corresponding illuminations were derived from the formula for the curve presented in Figure 1.

TABLE I
(See text for description)

Sensitivity Decrease below Optimum (Per Cent)	Illumination (Millilamberts)
10	11.00
20	2.10
30	0.78
40	0.37
50	0.20
60	0.12
70	0.08
80	0.06
90	0.04
100	0.03

The movie screen brightness recommended by the American Standards Association is between 9 and 14 foot-lamberts.[12*] This is

*1 foot-lambert = 1.076 millilamberts. Therefore, in the rough calculations used here, the two measures are taken to be approximately equal and are used interchangeably.

the illuminance on the screen with no film in the projector. The basic loss due to the gelatin of clear film is approximately 15 per cent. The polaroid filters and viewing glasses used in three dimension movies reduce screen illumination about 2/3. Finally, depending upon the material being filmed, there is a reduction between the brightest scene and the darkest of approximately eight times for color films and twenty times for black and white films.†

From these figures we may compute the screen illumination that might be expected under certain conditions. In a survey of 245 theaters,[12] it was found that about 75 per cent had screen brightness levels of above 9 foot-lamberts. If such a theater used the same projector for three dimension movies, the following figures would obtain:

Screen illumination	9.00 foot-lamberts
After 15 per cent reduction for film	7.65 foot-lamberts
After 2/3 reduction for polaroid accessories	2.55 foot-lamberts
After 20 times reduction for dimly illuminated scene in black and white film	0.13 foot-lamberts

Such a theater, then, would have a screen brightness of 2.55 foot-lamberts during the most highly illuminated scenes, and 0.13 during the darkest scenes. Referring to the table, we see that the depth sensitivity for the brighter scenes will be about 20 per cent below optimum, while for the dimmer scenes it will be reduced about 60 per cent. In other words, if under optimal conditions an individual can just perceive a difference in distance of two objects when they are separated by 50 mm., then this distance will have to be 60 per cent greater, or 80 mm., to be perceived as a distance difference if the objects are part of a dark scene projected under the conditions here described.

Clearly, greater sensitivity may be obtained in either of two ways. First, the screen brightness may be increased, and it is the present suggestion of the Motion Picture Research Council[13] that this be done. Second, movie producers may make their darker scenes not as different from the brightest scenes as in the past, lest the effect of depth be destroyed.

It is suggested by the Motion Picture Council that theater owners change their projection apparatus so that the illumination of the screen through the filters not fall below 9 foot-lamberts and that movie makers avoid very dark scenes, especially in 3-D movies. If these suggestions are followed, what will happen?

Screen illumination	9.00 foot-lamberts
After 15 per cent reduction for film	7.65 foot-lamberts
After reduction for dim scene only reduced by six times	1.27 foot-lamberts

†The authors are indebted for these figures, as well as for much other pertinent information about the motion picture industry, to Dr. Armin J. Hill of the Motion Picture Research Council.

In such a theater, the highly illuminated scenes will be characterized by a depth sensitivity only about 12 per cent below optimum; the dimly illuminated, by 25 per cent.

Finally, what will happen if a three dimension movie, made under present standards, is shown at a theater which has always had poor illumination? Such a theater might be a drive-in, which has a screen brightness of 2 foot-lamberts, a figure not out of line with common experience. The following would be the figures:

Screen illumination	2.00 foot-lamberts
After 15 per cent decrease for film	1.70 foot-lamberts
After 2/3 reduction for filter system	0.57 foot-lamberts
After 20 times reduction for dim scene	0.03 foot-lamberts

In such a theater, the brightest scene will be characterized by a depth sensitivity 35 per cent lower than the ideal, while objects in the darker scenes will require a separation twice that usually needed to be perceived as being separated in space. Seemingly, such an increase in threshold is too great, for bitter experience has shown that three dimension movies, as presently made, cannot be shown in drive-in theaters, one difficulty being that depth is not perceived at all times.

To check these figures against every day experience, illumination measurements were made for us at a Los Angeles theater by an optometrist, Dr. Melvin Nadell, to whom the authors express gratitude. Using a photometer, Nadell found that the illumination on the screen during the darker scenes of the motion picture "I, the Jury" were 0.1 foot-lamberts. The viewing spectacles given out by this theater transmitted only 40 per cent of the light. Thus, the brightness was, effectively, only 0.04 foot-lamberts, a figure which corresponds to a 90 per cent threshold increase. Nadell noted that the depth at this theater was not satisfactory, especially during the darker scenes.

It should be stated that the figures cited in the present section are oversimplified. For example, one further complication is the fact that screen brightness is not the same for all parts of the screen, being lower in the periphery than in the center of the screen. The authors, however, are not as much interested in solving the problem as they are in demonstrating how a mass of data, of a theoretical nature (the effect of illumination upon depth perception), can be put to use to solve a very practical problem (how bright the screen should be for three dimension movies). With the figures presented, we are certain that the solution can be reached. Clearly, from the preceding, the Motion Picture Research Council is on the right track in suggesting greater illumination on the screen and the use of less dark scenes in the production of movies. The present figures should give them a needed yardstick for further work.

OTHER PSYCHOPHYSIOLOGICAL PROBLEMS IN THREE-DIMENSION MOTION PICTURES

Essentially, the psychophysiological problems associated with the current development in the motion pictures may be divided into two main classes: (a) the mechanisms increasing the effect of spaciousness, and (b) the problems of visual comfort of the observer. Because problems in the first category may be studied by direct, acute, or short time experiment, they have been, for the most part, solved. The question of the comfort of the observer is, however, a more difficult problem. Depth may be perceived in a few seconds, but fatigue or discomfort (even though ultimately severe) may not be noticed for a period of hours. Experiments of this chronic type are less attractive, being time-consuming and costly and, for the most part, remain to be done.

Three-dimension motion pictures utilize the disparity clue. The normal scene is reconstructed by presenting to the two eyes views from two cameras in different positions and, hence, like the eyes, "seeing" things from slightly different angles. Ordinarily, the degree of accommodation, convergence, and retinal disparity bear particular relations one to another. Binocular vision developed in such an environment presents a neurologically linked set of functions in which accommodation and convergence influence each other in the sense that the activity of either produces some degree of response in the other. This synkinesis is, fortunately, flexible, otherwise no one could wear glasses or have binocular vision in the presence of marked ametropia.

The three dimension motion picture does not present to the eyes a wholly normal relationship between accommodation and convergence. The screen of the movie theater is seldom nearer than twenty feet and, in consequence, there is no stimulus to accommodation, whereas the varying degrees of disparity present a stimulus for convergence varying from parallelism to the marked convergence for objects apparently about to drop into the viewer's lap. These strains on the accommodation-convergence relationship have already appeared as a problem. There exist data on the average width of the "zone of comfort," the tolerance shown in cases of heterophoria and the degree of convergence required for pictures with ordinary or exaggerated disparity. An analysis of this information, completed by an experimental program, ought readily to furnish standards indicating the maximum depth effect that can be viewed over a long time without discomfort. This, then, represents one problem which optometry can help to solve.

Further data on the amount and type of discomfort resulting from various degrees of disturbance of the usual relationship of accommoda-

tion and convergence are needed, and optometric research could produce these data.

Closely related to the problem just outlined are the confusions in perception arising from conflicting clues to depth sometimes encountered in the use of exaggerated disparity. The recognition of depth or distance under normal conditions is a complex percept based both on a series of sensory clues and on experience of similar situations. Many of these clues have proven useful in two dimensional motion pictures. Geometric perspective, the overlap of the near object on the far and the relation of shadows are powerful monocular clues of relative distance, and these no less than the retinal disparity involved in duplicate pictures contribute to the effect of depth. Beside the limitation imposed by the accommodation-convergence relationship, situations may arise in which different clues suggest such different distances that they cannot be reconciled in a single consistent percept.

This type of conflict is well illustrated by an experimental situation encountered by the authors some years ago. The ordinary Howard test uses two rods which, if at different distances, present to the eyes a retinal disparity as well as differences of size. In an experiment, the moveable rod of a Howard apparatus was carried by a car on a miniature track and was so constructed as to decrease markedly in size as it approached the observer. When this was viewed monocularly, the size change was sufficient to give the illusion of the rod receding when it actually approached. When both eyes were used, the size clue was pitted against the disparity clue. The observer reported seeing the rod approach, recede, and approach again (while it was actually approaching all the time), indicating that first one and then the other clue dominated the preception. Conflicting clues have been studied by Schriever[14] and reviewed by Brunswik.[15]

Attempts to increase depth in movies by undue exaggeration of disparity result in a conflict between this and the size clue which cannot be combined into a consistent unified perception of the objects involved. Conflicting sensations may be not merely unpleasant but can result in nausea. All elements in a situation must present a total consistency for which experimental limits must be set. The result of independent and unrestrained emphasis on one clue, that of disparity, is bound to lead to pictures not merely unnatural but repellant and fatiguing. In this problem, too, optometric research can be of service. Further studies on the production of effects such as fatigue or asthenopia by conflicting clues will lead to establishment of suitable standards.

A third problem arises when the screen is viewed from an extreme lateral position. The oblique position distorts any picture, flat or

three-dimensional, but, in the latter case, asymmetrical accommodation and convergence are particularly involved. Ogle has reported some of the principles involved in asymmetrical binocular vision, and these can be extended to the situation found in the present movies.

The three problems listed here are by no means the only psychophysiological problems in three-dimensional movies. However, they do serve as examples of the type of problem to be encountered. Furthermore, they do illustrate the importance of basic data already on hand and the need for further research, both basic and applied. Finally, they point out the role optometry may play in such research.*

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*This is the first of four papers dealing with Vision and Three Dimension Motion Pictures, as presented before the American Academy of Optometry. The other papers of this special series will appear in following issues.

A STUDY OF VISUAL PERFORMANCE OF MENTALLY RETARDED CHILDREN*

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INTRODUCTION

Physical defects exist even among some people of the highest levels of intelligence. Among the feebleminded the frequency is greater than that in a randomly selected population, and it is still greater for the imbecile and idiot grades.[1] Although physical anomalies occur in persons who are not otherwise abnormal, there can be little doubt but that they are more numerous among psychopaths and aments than in the general population. Further, their number and severity are, on the whole, directly proportionate to the degree of the defect.[2] The medical records of patients at institutions for aments reveal the large number of illnesses that beset these individuals and the necessity for frequent medication and treatment. Information about the type and incidence of visual handicaps among these subjects has, however, not been available. To obtain such information, the visual performance of a group of mentally retarded children at the Modesto State Hospital, Modesto, California,‡ was investigated.

METHOD

A battery of tests, adapted from the published works of those who have worked with children, was prepared. The studies of Getman[3] at the Yale University Institute of Child Development was helpful, although many of the methods could not be used since the Modesto project was conducted by only one investigator and also because of the limited intelligence and cooperation to be expected from the mentally retarded children. The data obtained by Hirsch[4] on children of grammar school age were also used to advantage.

All testing was performed in a darkened room at the hospital. A 16 mm. projector was set up and was kept running continuously. The screen was placed twenty feet from the subject's chair. This screen with

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projected image was the fixation target for all tests unless otherwise mentioned. The patient next in line to be examined was seated in a chair to the rear of the room and was required to watch the movie through a pair of +1.50 D. spheres. This was done to relax accommodation for subsequent retinoscopic findings (Hirsch[5]).

I—The *name, age* and *I.Q. rating* of all patients were recorded. The following formula was then applied to determine the mental age of each patient:

$MA = CA \times IQ$

Where MA is the mental age and CA the chronological age and IQ the intelligence quotient rating expressed in percentage.

For instance a patient age 15 with an IQ of 30:

$MA = 15 \times .30$

MA = 5 years mental age.

For patients whose chronological age is over 15, the figure 15 is used because for all practical purposes the development of the capacity to learn has reached its peak at that age. (See Table I and II.)

TABLE I
Analysis of chronological age and sex

	Boys	Girls	Total
Age 5-9	10	7	17
Age 10-14	30	23	53
Age 15-20	12	11	23
Total	52	41	93

TABLE II
Analysis of mental age and sex

	Boys	Girls	Total
Under 5	44	37	81
Over 5	5	3	8
Unknown	3	1	4
Total	52	41	93

II—*Versions:* The patient was confronted with a pencil flashlight at a distance of about 40 cm. The light was moved to each of the 8 cardinal positions. First the monocular and then the binocular pursuits were noted and recorded. (See Table III.)

III—*Near Point of Convergence:* A small bell was suspended from a piece of black string and dangled before the patient's eyes at a distance of 40 cm. After the patient had fixated the bell it was slowly brought closer to the eyes in the median plane until one eye deviated. Recorded, was the near point of convergence and which eye deviated. (See Table III.)

IV—*Cover Test:* The clinical, alternate, cover-uncover method was used. (See Table III.)

V—*Ophthalmoscopy:* Because of the abnormally fearful attitude of most of the subjects, only the grossest observations were possible. Therefore only the most obvious cases of pathology were uncovered. (See Table III.)

VI—*Retinoscopy:* The results of this test were grouped into arbitrary classifications as follows:

Hyperopia. Defined as the need for a plus lens in excess of one diopter to neutralize the reflex.

Normal. Defined as the need for any lens from plus one diopter to minus one diopter to neutralize the reflex.

Myopia. Defined as the need for a minus lens in excess of one diopter to neutralize the reflex.

Astigmatism. Defined as the need for a cylindrical lens of one and one-half diopter or more to neutralize the reflex in all meridians. Equivalent spheres were used, to include these cases in the data. (See Table IV.)

TABLE III

Analysis of visual characteristics of 93 mentally deficient children.

APPROACH	Normal 54	Fearful 27	Extremely Fearful 12	No Verbalization 55
VERSIONS	Normal 33	Nystagmus 18	Jerky 34	Paresis 11
NEAR POINT	10 cm. to 20 cm. 42	O.D. Out 26	O.S. Out 26	Not Possible 26
COVER TEST	Normal 43	Esotropia 19	Not Possible 9	Not Possible 21
OPHTHAL-MOSCOPY	No Pathology 60	Cataracts 4	Suspected Pathology 6	
PUPILLARY REFLEXES	All Normal 60	Accommoda-tive Weak or Absent 23	Direct Weak or Absent 16	Consensual Weak or Absent 20
BINOCU-LARITY	Present 37	O.D. Suppresses 10	O.S. Suppresses 10	Not Possible 35
VISUAL ACUITY	20/40 or better Either Eye 27	20/50 or less Either Eye 21	Reverse * 10	Exotropia 43

*Acuity is better in eye with greater refractive error.

TABLE IV

Analysis of the spherical refractive states of 90 mentally defective children. Chronological

Age	Emmetropic	Hyperopia*	Myopia*	Not Possible	Total
Age 5-9					
Males	1	8	2	1	12
Females	0	5	1	0	6
Age 10-14					
Males	6	16	6	1	29
Females	1	10	5	4	20
Age 15-20					
Males	1	6	4	1	12
Females	2	3	6	0	11
Total	11	48	24	7	90

*Myopia and Hyperopia of 1.00 Diopter or more.

VII—*Pupillary Reflexes:* A pencil flashlight was used as a source of light and the direct, consensual and accommodative pupillary reflexes were investigated. (See Table III.)

VIII—*Binocularity:* A hand stereoscope was positioned before the patient's eyes and the D.B. 10 Keystone card was exposed. This is the dog and pig card. The reaction was recorded exactly as the patient reported. (See Table III.)

IX—*Visual Acuity:* A modified form of the illiterate E test was used. The patient was given a wooden letter E, 18 cm. square to manipulate. The examiner from a distance of 6 M.—exposed a series of letter E's one at a time, of diminishing size and oriented in different directions. The patient was instructed to "turn your E card until it looks like mine." The last correct reaction was recorded. The tests were first taken monocularly, then binocularly. They were sometimes repeated at 3 M. (See Table III.)

DISCUSSION OF RESULTS

Almost three times the number of children reported on here were seen by the author. From over 300 possible reports, over 200 did not have sufficient data to warrant inclusion in this study. About 100 patients are included in these data. The number of children mentioned hereafter can, therefore, be considered to be percentages for all practical purposes. The group which was tested was almost equally divided between boys and girls and the greatest number fall in the 10 to 15 year chronological age category. One of the many difficulties encountered was the fact that over one-half of the subjects tested had a mental age of less than five years. They had a low level of personal social behavior. Their reactions to persons, responses to overtures and commissions and adjustments to their environment were subnormal. This explains the

high number of patients upon whom it was later found impossible to record useful findings.

The patients examined were found to vary extensively in their reaction to the examining situation. Those that were fearful were extremely so—to the extent that not even observation was possible in some cases. Those that were friendly were often annoyingly so—to the extent that they would use subterfuge to be again included in a subsequent examining group. Noteworthy was the fact that most of the patients were unable to verbalize intelligibly. One can easily imagine the obstacle that this would place in the path of future tests.

The results of the version test were significant in the large number, (18), of children with nystagmus. There was also a tremendous variety of types of nystagmus. There were children with binocular nystagmus, monocular nystagmus and even a different rate of nystagmic motions between the two eyes. A number of reasons would account for this. First there is the matter of poor acuity. Amblyopia would cause poor fixations which might develop into nystagmus. The large number of squint cases would also be a factor. Finally an examination of the admission records disclosed a large number of birth injuries listed. Conceivably these injuries could have caused damage to the cortical areas resulting in a condition of nystagmus.

The cover test revealed more than 20 children with strabismus. Hirsch[4] indicates that between 1.1 and 1.8 per cent of normal children have tropias. Although the criteria used varied the author feels that the percentage of increase is significant.

Retinoscopy indicated that the distribution of refractive errors varied considerably from that of normal children. Again referring to the work of Hirsch[4] who indicates that among children of grammar school age, approximately 10 to 15 per cent have myopia, 5 to 7 per cent have hyperopia and 5 to 7 per cent have astigmatism. We found over 45 cases of hyperopia, less than 25 cases of myopia, and about 10 normal. This would indicate a much greater amount of hyperopia in the group tested than in the normal population.

The tests of pupillary reflexes revealed a relatively large number of children with an abnormality. This is probably the least reliable of the battery of tests used because so much judgment on the part of the examiner is required. The difference between a normal pupillary reaction to light and a poor reaction is sometimes very slight.

One of the more significant findings was visual acuity. In the usual practice of optometry the author would expect a negative correlation between myopia and visual acuity. This was not true in 10 of the

patients tested. In these cases the eye closer to emmetropia had a lower acuity than the eye with greater refractive error. This was not the same group of subjects who had nystagmus and so some other reason for their deviation from normal must be found.

The test for binocularity provided a very good check on the squint results. There were 20 children with squint as previously indicated, and there were 20 with suppression of the vision of one eye in the binocular act. The subjective reaction of these patients to the dog and pig card varied extensively. Sometimes one grunt as compared to two grunts differentiated suppression from binocularity. Precious few times was the author rewarded by an intelligible indication of what the pictures were rather than a simple indication of whether there were one or two things.

Generally speaking the author found a frequent exaggeration of visual symptoms. One youngster followed us around from the first day we were there to almost the last repeating time and again, "I can't see, I can't see." This was one of the patients who was later classed as visually normal. On the other hand there was one child in whom the correction of a gross visual anomaly showed little performance improvement. This was our very first patient, a male, age 16, with an IQ of 50. It required almost nine diopters of plus lens power to neutralize the reflex. Since the patient had never worn glasses it might be expected that the correction of such a large amount of ametropia would cause not only visual improvement but better performance as well. The visual improvement was achieved. The IQ remained the same.

CONCLUSIONS

It is known that the mentally retarded child is subject to a greater number of physical ailments than the normal. Certainly hospital records indicate that patients in the Modesto State Hospital receive a tremendous amount of care and medication while in this institution. On the basis of the excessively large number of visual anomalies found, the author concludes that the statement can be expanded to read "the greater the mental deficiency, the greater the physical abnormality, and the greater the visual anomaly."

Duke-Elder[6] states that nystagmus is associated with convergent squint. The author considers it significant that the two most outstanding findings were the large number of children with squint and nystagmus. This would support the previous work which posed the possibility of a syndrome linking the two anomalies.

Gesell[3] states that the role of cerebral injury in the production of visual abnormalities is greater than generally conceded. He states that

strabismus is a symptom of minimal injury. The hospital admittance records show frequent references to "birth injuries" as the probable cause of the mental abnormality. Considering the high frequency of birth injuries in these patients and the accompanying high number with strabismus, the above statement by Gesell would seem to be substantiated.

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BOOK REVIEW

PERIMETRY. Joshua Zuckerman, M.D. Published by the J. B. Lippincott Company, Philadelphia. Cloth. 1954.

This new text is a welcome addition to the literature in field studies. It has just the right amount of emphasis on instrumentation, technique, anatomy and interpretation of normal and abnormal field disturbances. Two exceedingly useful and well written sections are the first and last parts dealing with what the author calls "Descriptive Review of Perimetry." There are many other parts worthy of note, such as "Pitfalls in Perimetry" and the "Tabular Review of Perimetry," which add to the value of this text. For the examiner at the clinical level many helpful hints and procedures will be found that make it a very practical treatise. For instance, a short chapter explaining by the "how-to-do" method, "the author suggests directing particular attention to certain 'tell tale areas' that are most often characteristically effected in the field of vision," and then procedes to describe thirteen areas in which the examiner is to be especially alerted. This book should be in the library of anyone who does work in the visual sciences.

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THE RELATIONSHIP OF THE INTRINSIC GEOMETRIC PROPERTIES OF AN OBJECT TO THE APPARENT SHAPE*

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The purpose of this paper is to describe several investigations concerning certain aspects of space perception and their relationship to the so-called "constancy" phenomena. More exactly, this paper will deal with the perception of object shape when the condition of encounter is most primitive or basic.

This condition of observation is achieved by placing an object, say an ellipse or a circle, in what might be termed an undifferentiated visual field, i.e., one devoid of all "cues" and without a definable background for the perceived object. The object exists, as it were, as if in a void. This condition is, of course, in contrast to the everyday conditions of vision, and also in contrast to usual laboratory conditions of study. An undifferentiated visual field presents the experimenter with an unique opportunity to study visual behavior. Study under these conditions allows an investigator to discover the role that highly specific changes on the retina or retinas play in the perception. Well defined changes in stimulation can be studied without the situation being complicated by depth cues, e.g., interposition cues, linear perspective, light and shape, texture gradients, and so forth. The subject experiences an object that is disembodied from all surfaces and other objects, but that nevertheless still possesses the familiar object qualities of color, shape, size, distance, etc. This type of visual field permits very rigorous laboratory control of variables external to the organism.

In the interpretation of his results, however, the experimenter may not wish to limit himself only to gaining an understanding of the specific effects that an undifferentiated visual field has on the perception of a certain group of object properties. The data may also be of theoretical relevance. Certain psychologists, such as Professor Bartley, are constantly seeking more generalized statements to account for visual experience. Greater generalization is sought because any law describing the phenomenal world just as any law describing the physical world

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is valid only to the extent to which it can account for all the facts known about a particular phenomenon. In order to confirm, or in some cases even formulate, the statements dealing with the phenomenal world, it is sometimes necessary to study behavior occurring under extreme conditions of stimulation. The undifferentiated visual field approximates one such ideal extreme in the case of visual behavior. In the larger sense, then, the study to be touched upon represents an attempt to provide a more adequate answer to the perennial question, "How do we see things as we do?"

A great deal of formal quantitative work has already been done in the area of object perception. Doubtless the terminology and associated concepts are already familiar: "constancy" is perhaps one of these terms.

The term "constancy" has a somewhat misleading connotation. This is because the word nowadays is used in a relative rather than in an absolute sense. Nowadays it simply refers to the tendency for a perceived object property to remain fairly stable despite notably large shifts in the physical environment in which it is presented. Under ordinary visual field conditions the object properties of color, shape, size, distance, show constancy.

Thouless,[5] who is perhaps the best known worker in the area of object constancy, employs three conceptual objects in accounting for constancy, or, as he expressed it, "phenomenal regression." These are the concepts of the "real object," the "stimulus object," and the "phenomenal object." The term "real object" refers to the concrete in-space object. Its characteristics are measured under standardized conditions, and are thus independent of any experimental influence: for example, a white circle is always white in color, and always has a shape ratio of one. The retinal image of the real object is styled the stimulus object, and the perception is called the phenomenal object. The following example, a traditional type of investigation concerning "phenomenal shape," will illustrate the application of these terms to experimentation. In this experiment a series of circles and ellipses were used as the real objects. These objects were cut out of cardboard and oriented in various ways to the observer. No attempt was made to control the visual field surrounding the object: an ordinary room with some furniture was used. The observer was instructed to look at the experimental object and draw the shape that he saw. When the data were gathered and analyzed the experimenter found, as had previous experimenters, that the resulting phenomenal shapes were related to, but not copies of, the stimulus shapes. In addition, however, he discovered

that the characteristics of the perceived objects were quite closely related to the characteristics of the real object. Traditionally, then, the investigator studies the relationship of the experienced object to the stimulus object or real object. Usually he studies the way and extent to which the perceived object differs from the retinal image and approaches that of the physical object in regard to color, shape, size, inclination, or other attribute.

When assaying the relationship, the physical object and correlating stimulus pattern usually serve as referents, and the experienced object is related to these by means of a Brunswik or Thouless ratio. Thouless and Brunswik ratios are very similar. Both are attempts to express the degree to which the perceptual object properties are constant or identical with those found in the real object. In construction of their ratios both authors have employed similar concepts although they have used a somewhat different terminology. Both ratios implicitly treat perception as though it is veridical in nature, that is, both Thouless's so-called "law of phenomenal regression" and Brunswik's "psychology of objective relationships"[1] tend to center their explanations concerning human visual experience in the object world rather than in the organism. For these psychologists, the fact that two identically shaped images on the retina sometimes result in experiences of different rather than similar shapes is explained on the basis of the properties of the physical object. This fact will have considerable importance in the present discussion.

As an example of this sort of interpretation, let us suppose that under ordinary visual field conditions, a circular stimulus has been inclined so that it forms a retinal image of the same shape as that of a certain tilted ellipse. If both forms are observed and drawn we will discover that the circle is perceived to be larger than the ellipse even though the retinal images are the same in size and shape. An object-centered psychologist would probably explain that this occurred because the character of the real object was in some way indicated to the subject. Ordinarily he would explain this by saying that "regression toward the real object," that is, constancy, had occurred in each case. However, different shapes are seen because the cues resident in the visual field indicate to the observer, not necessarily on the conscious level, what the objects correlated with the retinal images really are. He would perhaps continue by saying that this information cannot be ignored by the perceiving organism, but neither can it be accepted without modification because it is contrary to the properties of the retinal image. Hence since two different objects cannot be seen simultaneously either, a com-

promise occurs. Thus, the fact that a copy of the stimulus image is not seen in either case, and the fact that the tilted circle, even though the retinal images are identical, is held to faithfully reflect the "pull" exercised on the perception by the physical object.

Clearly opposed to the object-centered psychologist in his interpretation of such data is the organism-centered psychologist. He would not assume that perception can tend to only one end result. In fact he would emphasize the fact that a single set of external physical conditions can yield a series of perceptions showing considerable variation from time to time depending upon the way the organism organizes the stimulus materials awarded it. His inquiry is centered about the organism's use of stimulus material and not about the nature of the stimulating object. His, and our, position is that any explanation of human behavior, however convenient, couched in terms of events external to the organism, is bound to be proven fallacious. Perceptual behavior is thought of as being problem solving in nature. Any given retinal image is thought of as providing material for almost an infinite number of phenomenal end results. The assumption is not made that perception is, in essence, always veridical in nature.

As already said, the results of previous experimentation have shown that the phenomenal shape varies as a function of collateral cues, or better said, collateral retinal stimulation. Usually a decrease in the amount of phenomenal regression accompanies the elimination of the usual field cues, that is, the more impoverished the visual field, the more the phenomenal shape usually approaches being a copy of the stimulus shape. The "law of phenomenal regression" and the constancy hypothesis assume that the perception resulting when visual field influences are totally lacking will be a stimulus copy. However, despite this assumption, no formal study under these conditions has been made.

Recently however, in an attempt to answer this and other related questions, Haan and Bartley,[2] and Nelson[3] investigated the effect of viewing a circle and a series of ellipses in an undifferentiated field. It was expected that the absence of cues in the visual field would introduce a great deal of ambiguity. Perceptions and judgments would have to be structured solely around the target properties. It was felt that if the situation could be sufficiently impoverished it might well result in perceptual data that an object-centered approach could not anticipate theoretically.

In these experiments the physical objects were outline figures mounted at angles of inclination varying from upright to 67.5° tilt.

The use of outline figures eliminated any texture gradient cues that might be present if objects possessing a surface were used. The outline figures were coated with a paint that could be activated only by ultra violet light. The experimental materials were presented in a darkened room in which all surfaces and equipment were painted a flat black. The source of light was unknown to the observer and the subjects were seated at distances sufficiently great to eliminate common physiological cues. The subjects were first asked to draw the shape that they saw, and, second, several days later, to estimate the angle of inclination they judged the shape to possess. A large number of responses were obtained from over thirty subjects. The data were analyzed first with respect to shape. Shape was operationally defined as in the case of Thouless, as the ratio of the minor to the major axis. It was found when the data was analyzed that the ratios of the minor to the major axis in the drawings did not represent a copy of the stimulus shape. The perceived shapes had indices obviously both significantly larger and significantly smaller than those of their respective stimulus shapes.

As previously indicated the "phenomenal regression" equations of Thouless and Brunswik were designed to enable one to express the extent to which a perceptual quality approaches the same quality of the physical object, i.e., constancy. Implicit in the formulation of the "law of phenomenal regression" is the assumption that all phenomenal shape ratios will fall somewhere between zero and one. In fact, these measures have been very useful because they permitted each result to be referred to a well defined range of values. It was possible to obtain comparable figures for very diverse shapes and stimulus constellations because each range was defined in an identical manner. Thus the occurrence of twice as many "phenomenal shape" ratios outside the range tacitly assumed by the equation as within the range is of practical as well as theoretical importance. These consequences could prove serious enough to impair much of the value of the measures.

In addition there is an implication to be drawn from the data regarding the "object" vs. "organism" centered controversy. That is, when an experimenter makes the assumption that all "phenomenal shape" ratios will fall between zero and one, a contingent assumption is also necessary. The contingent assumption makes not the organism, but the real object the organizing force. Obviously the results reported, however, were not influenced by a real object in any way, or there would have been, at minimum, a simple copy of the stimulus shape. Moreover, at this point it is evident that if one intends to organize his thinking in the traditional manner it will be necessary to speak of "progression from

the real object" as well as "regression toward the real object." To do so would be to admit the inadequacy of a conceptual system. It is felt that the concept of the real object and the indices purporting to measure constancy are artifactual. It is felt that they are inventions arising from particular conditions of study and that they do not fairly reflect the nature of human visual behavior. In these results we feel one can clearly see that the concept of the real object and the indices of constancy are, in the broader sense, theoretically inadequate. This is only another way of saying that they cannot handle all the facts of the case.

If we would allow the matter to rest without further discussion, many might suppose, either, that inclusion or consideration of the real object is merely superfluous, or, worse, that the real object is no more than a linguistic invention. An example taken from the recent literature will show that this is far from the case.

In the study to be cited the experimenter[4] attempted to test a hypothesis called the "invariance hypothesis." This hypothesis seemed to be related to the issue of constancy. The hypothesis, if confirmed, could be interpreted as showing that shape regression is not a result of a perceptual process super-imposed upon the primary sensation, that is, the stimulus shape, but rather that constancy is a result of the figure being experienced as an object in space. Confirmation of the invariance hypothesis would tend to demonstrate that the "phenomenal regression" found in shape perception is conditioned by the fact that a shape is always seen as a shape in space, that a shape is always a shape in a given orientation, and never a shape experienced in isolation. Confirmation of the hypothesis might have been claimed if it could have been demonstrated that a perceived shape combined with a perceived tilt yields an invariable referent object.

On the basis of other related investigations the probability of this being the case is high. In the experiment cited, however, the experimenter was, for the most part, unable to demonstrate any such relationship to exist between the perceived shape and the perceived inclination. This may well have been due to certain assumptions inherent in the methodological design.

Inherent in the methodological design was the assumption that there was a referent object, namely the real object. Because of this, the hypothesis was tested by determining whether observers who misperceived the tilt of the real object would misperceive the shape of the real object by a geometrically equivalent amount. Thus, if an inclined object was perceived as being more tilted than actually was the case, it

was expected that the observer should then perceive the shape as being just so much longer in the vertical dimension than actually the real object was. Hence in the attempt to verify the hypothesis the traditional conceptualization was employed. The determining role in the perception was awarded to a non-existent. That is, it was centered about the real object.

Another formal quantitative study of the phenomenon has recently been made.[3] This study featured a methodology substantially different from that criticized above. Nelson investigated the phenomenon by relating the judgments of inclination to the phenomenal shape data described earlier. Perceived shape and the judged inclination of an object were found to be related in an orderly fashion. This relationship was readily evident when phenomenal shape was plotted against judged inclination, and found to represent approximately a straight line function. Conformation is felt to have been largely possible because the test of invariance was not confounded by those assumptions inherent in the constancy hypothesis. That is to say, no assumptions concerning the real object were entertained. This was fortunate since it is obvious from the shape of the described function that the relationship of these phenomenal properties differs a good deal in character from the graphed function the correlated objective properties would assume. That is, in the case of judged inclination and perceived shape, the plotted relationship representing perception of a physically circular shape at all the inclinations used roughly a straight line function, while the correlated objective properties, stimulus shape and real inclination, on a similar plot would describe a curvilinear function.

Although introduction of a real object into the picture seems unwarranted, it is possible to deduce what might be called a "hypothetical object" from the new function. If the experimenter chooses to posit such an "object" however, he must constantly bear in mind that this "object" is but a convenient shorthand symbol and not a perceptual determinant. Such inventions become dangerous if the experimenter in his thinking begins to impose them upon the data and loses sight of the fact that they are but abstracts of the data.

At the present time experimental investigations are being undertaken that may ultimately make possible a partial reformulation of the problem concerning perception of shape and orientation. These investigations aim at determining the role of certain variables in determining what is seen. The list of relevant variables affecting perceived shape and perceived inclination can not be limited only to factors related to the structure of the perceived object or to the correlated visual field. In an

undifferentiated visual field any factor that might provide what has been analogously called a "premise" for the perception, merits study. If enough of the relationships were known, the perceptual process leading to a given perceptual end result would be adequately described through use of a multiple regression equation. However, this is beyond the scope of the present considerations.

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BOOK REVIEW

DISEASES OF THE RETINA. Second edition. Herman Elwyn, M.D. Published by the Blakiston Company, Inc., New York City. 713 pages. 243 illustrations, with 20 in color. Cloth. 1953.

Certain texts dealing completely with specific phases of the eye have become definitive works in these fields. Elwyn's book has become such a text. The new second edition contains revisions, particularly in those areas like essential hypertension and diabetic retinopathy where a good deal of recent research has resulted in progress. A section of thirty pages on retrolental fibroplasia has been added: the 37 references at the end of this chapter, all dating since 1942, indicate both the recency and the relative importance of this disorder.

Despite the limited scope of the book, optometrists will find it a valuable addition to the pathology section of their libraries.

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THE DEPENDENCE OF CYCLOPHORIA ON CONVERGENCE, ELEVATION AND THE SYSTEM OF AXES*

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INTRODUCTION

It is the purpose of this paper to present data of several investigators showing the effect of elevation and convergence of the lines of sight on cyclophoria; to present the problem of measuring and specifying cyclophoria; to present data obtained by the author with a synoptiscope; to show how these data were converted mathematically to be comparable to the other data presented; to compare the results found by Listing in monocular eye movements with those found in the binocular situation; to attempt to rationalize the innervation and musculature involved and to consider some practical implications.

In general terms, cyclophoria is here considered to be the deviation of the vertical meridians of the two retinas away from parallelism when the eyes are torsionally dissociated by some such target as the modified Volkmann's Discs, Figure 1.

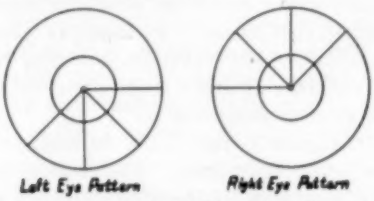

Figure 1. Cyclophoria Measuring Targets.

INFLUENCE OF ELEVATION AND CONVERGENCE ON CYCLOPHORIA

Cyclophoria varies considerably with changes in convergence of the lines of sight and with their elevation or depression as is shown by the data of the following investigators. Landolt's[1] data, Figure 2, were taken with the Hering isoscope.[2] Elevation was varied by changing the head posture while the vertical meridian was used as a reference line for measuring cyclophoria. Some of Landolt's intermediate curves have been omitted for the sake of clarity. As elevation decreases, plus

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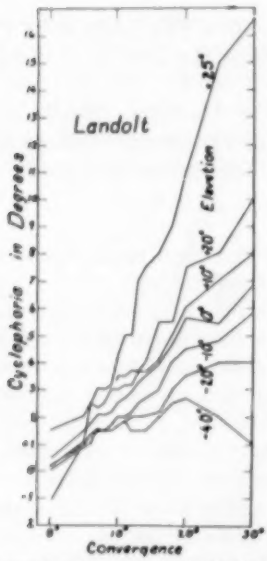

Figure 2. A portion of the cyclophoria data of Landolt.

cyclophoria (excyclophoria) associated with convergence drops toward zero. Landolt reports that negative cyclophoria (encyclophoria) was obtained at levels below —40° elevation, but that he considered these data as lacking in sufficient accuracy to be presented, due to the ocular discomfort at these extreme positions.

Hering's[3] data, Figure 3, also show the relationship between convergence, elevation and cyclophoria. The region of curve crossover indicates the level of elevation where no cyclophoria is induced by convergence. Here, as in the experiments of Donders and of Landolt, the changes in elevation were accomplished by tilting the head forward or backward while the plane of regard remained horizontal. Probably the high values of convergence and of negative elevation of the lines of sight account for the presence of a significant number of negative values of cyclophoria.

Donders'[2] data,* were obtained by using horizontal target lines. He located the degree of elevation at which zero cyclophoria accompanied convergence. This level varied from subject to subject, but the values for seven individuals presented by Donders averaged about —26° elevation. Donders himself had zero cyclophoria at about —40° which he considered exceptional.

*Not included in this paper.

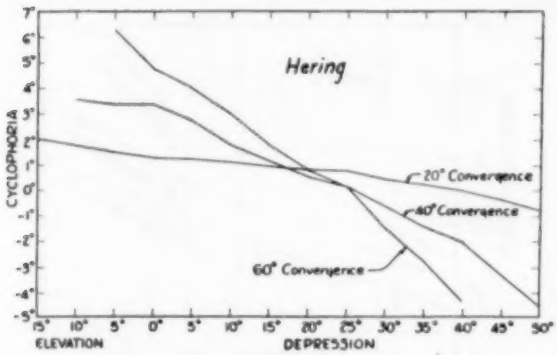

Figure 3. Hering's data. Region of crossover of curves gives the value of the depression of lines of sight necessary to eliminate cyclophoria changes due to convergence.

Carow[4] utilized a rivalry type of target. The left eye target consisted of green vertical and horizontal lines while the right eye target was a single vertical red line. He used 107 subjects of an apparently typical eye population, see Figure 4. Where necessary each subject was given a visual examination and the correction lenses which yielded the best visual acuity were used for the experiment. The results are in general agreement with data previously presented. His data reveal that slightly less than one-fifth of his subjects had a level of elevation, like Hering's, of approximately —20° where cyclophoria did not change with convergence, the remaining four-fifths requiring greater depression of the lines of sight, in the direction of the data of Landolt.

Hermans[5] obtained data on 104 "normal" healthy young men, see Figure 5. His data and formulae are based on torsional values for each eye separately. The justification for this is not clear inasmuch as no attempt was made to determine the absolute reference meridian of either eye and his equipment actually measured the total amount of cyclophoria, but was scaled to indicate only half of the total. Hence for comparison purposes in this report all values have been multiplied by two. Likewise the values of convergence as given by Hermans are monocular and had to be doubled to obtain the total convergence.

Hermans derived an empirical equation which represents an approximation of cyclophoria within the limits of convergence and elevation that he used. Beyond 20° of convergence it will give values of cyclophoria which are not in agreement with data actually obtained by other experimenters, see Figure 5. Hence this formula is not of general value in predicting torsions associated with convergence.

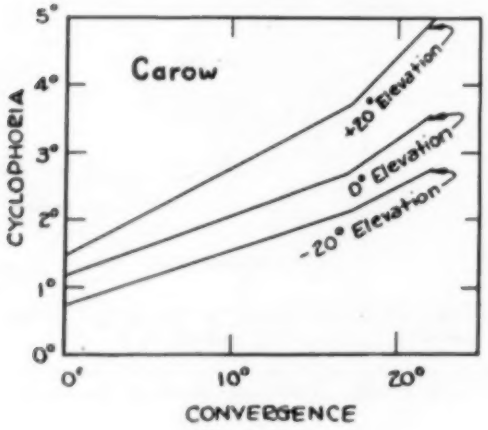

Figure 4.

MEASURING AND SPECIFYING CYCLOPHORIA

The presence of a measured cyclophoria involves a real or apparent rotation (torsion) of one or both eyes about their lines of sight. The terms "false" and "true" torsion (and related terms) complicate our literature.[9, 10] "False" torsion is a geometrical problem involving the comparison of one system of axes with another system of axes.[10, 11] "True" torsion is considered to be a real rotation of the eye about its line of sight. The problem becomes further complicated when we realize that we can only specify true torsion with respect to some system of axes, hence it varies with the system of axes of the measuring equipment.

Fry and others[7] propose to eliminate the distinction between the so-called false and true torsion by the proper choice and standardization of a system of axes. Any torsional deviation from alignment within this system would be considered a real rotation about the line of sight. The effects of various systems of axes projected on a tangent screen is shown in Figure 6. Figure 6A is the projection of the system used by Fick, see Figure 7A. Figure 6B is the projection of the system used by Helmholtz, see Figure 7B. Figure 6C is Listing's system and is analogous to the system of axes of the perimeter.

CORRECTION OF THE SYNOPTISCOPE DATA

A study of cyclophoria, as affected by elevation and convergence, was undertaken using the synoptiscope. This instrument is a mirror haploscope which uses Fick's system of axes. The synoptiscope was modified by substituting a biting board for the chin cup. Corneal

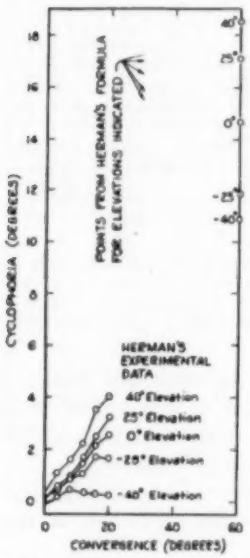

Figure 5. Hermans' data. An idea of the curves described by Hermans' formula can be had by connecting the points on the upper right side of the graph with the corresponding curves at the lower left.

aligning sights were added to help position the center of rotation of each eye over the corresponding fixed vertical axis of the instrument. A lever extension on the target housing was provided to make the cyclophoria measurement easier, and the targets in Figure 1 were used.

Each point presented in the data is an average of four or five cyclophoria settings. About half of the data were obtained with convergence near the phoria position while the remainder were obtained with convergence near the base-in or base-out limits of clear single vision. There is some evidence that changes in accommodation do not effect cyclophoria as long as convergence is held constant.[12]

All of the data obtained using the synoptiscope had to be corrected for the inherent torsion errors of the instrument itself due to the system of axes (i.e. fixed vertical axis and movable horizontal axis as in Figure 7A). The criterion for a "vertical" reference when the eyes are elevated and converged is a line which is perpendicular to the plane passing through the centers of rotation and the point of fixation.[7] The angular deviation of the vertical lines of the targets from this reference line which is required to make them appear parallel provides a measure of cyclophoria. The synoptiscope torsion scales do not give

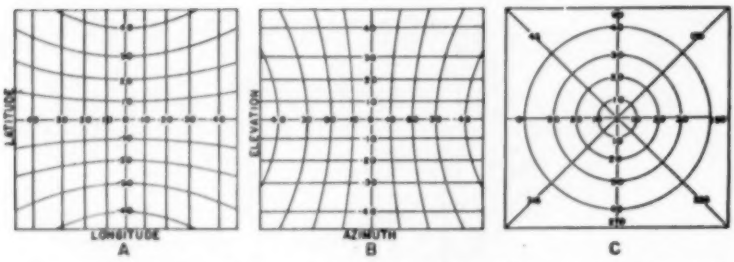

Figure 6. Projection of the vertical and horizontal meridians of three hypothetical instruments, each with a different arrangement of axes to permit movements into secondary positions. Part A is analogous to Figure 7A and Part B is analogous to Figure 7B. Part C is the system of axes described by Listing and is analogous to those of the perimeter.

the deviation from this reference line because the vertical reference line of the synoptiscope (due to the system of axes of this instrument) is perpendicular to the line of sight and lies in a plane which also contains the vertical axis of rotation.

The following formula makes it possible to compute the cyclophoria based on the Helmholtz system of axes from the raw synoptiscope data.

$$\tan \mu = \tan \phi \sin \sigma \qquad (1)$$

where:

μ = the torsion of the reference meridian for the right or left arm of the instrument.

ϕ = the angle of longitude of the fixation point.

σ = the angle of latitude of the fixation point.

$$\text{Cyclophoria} = (S) + (\mu_R - \mu_L) \qquad (2)$$

where S is the synoptiscope cyclophoria data.

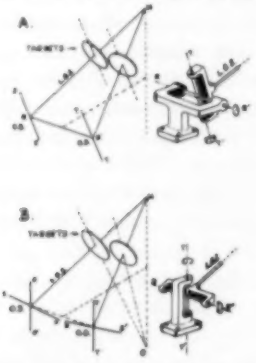

Figure 7A. Fick's system of axes, used for example in the synoptiscope and the rotoscope. Figure 7B. Helmholtz system of axes, used for example in the orthorater and the eikonometer.

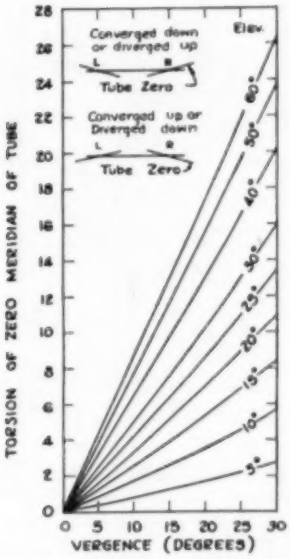

Figure 8. Computed deviations of the zero meridian of each tube or arm in the instrument from the plane analogous to the plane of regard. Vergence is the lateral deviation of either tube away from the primary (straight ahead) position.

Counterclockwise instrument torsion occurs in the up-and-right or down-and-left positions of the instrument and is considered to be negative: clockwise instrument torsion occurs in the down-and-right or up-and-left position and is positive. Figure 8 shows the instrument "torsion" which occurs with the synoptiscope, as computed from formula (1).

The corrected synoptiscope data are presented in Figure 9. A plus cyclophoria value indicates excyclophoria and a minus value indicates encylophoria. It may be seen that a definite tendency for an increase in excyclophoria exists for increases in convergence and elevation.

LISTING'S LAW

None of the above data relating to cyclophoria with converged and elevated lines of sight can be accounted for by Listing's law of monocular eye movements. According to this law, the torsion of either eye, when it is deviated from the primary position, can be calculated with the following formula:

$$\frac{\text{Tan } \mu}{2} = \frac{(\tan \gamma)}{2} \cdot \frac{(\tan \beta)}{2}; \qquad (3)$$

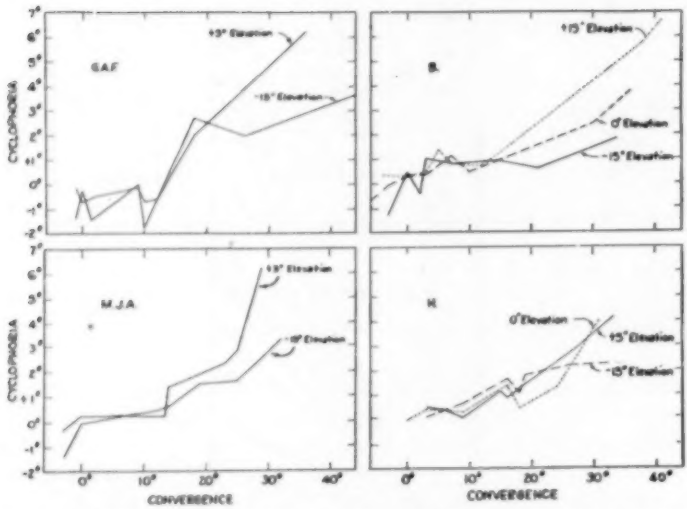

Figure 9. Synoptiscope data, treated as indicated in Figure 8 to make it comparable with the data of Landolt and others.

where μ is the angle of torsion, and γ and β are the angles of longitude and latitude specifying the extent of the eye movement. The primary position of the eye is that position from which lateral and vertical monocular movements can be made without inducing torsion.

Figure 10 represents the cyclophoria which might be expected if the binocular torsion effects of the eyes with elevated and converged lines of sight could be predicted by Listing's law.[10] These data are calculated on the further assumption that the primary position of each line of sight lies straight forward with the head erect and are presented in terms of the Helmholtz system of axes.

It is obvious that these data do not agree with the experimental data and hence it is necessary to differentiate between torsions which are produced essentially under monocular conditions, and torsions which are apparently bound up in an innervational manner with convergence. It may be seen by studying Figure 10 and the data of Landolt, Figure 2, that the experimentally obtained cyclophoria values could be a combination of a convergence-induced component and a monocular positional component such as that indicated by Listing's law.

CONSIDERATION OF MUSCLES AND INNERVATIONS

There is little question that the cyclophoria findings represent a real rotation of the eyes about their lines of sight. The extraocular

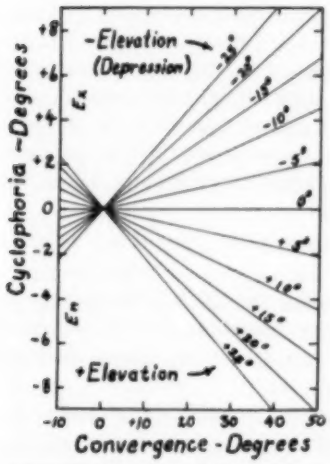

Figure 10. Cyclophoria-convergence-elevation relationships to be expected if Listing's law of monocular torsions could be applied to the binocular situation.

muscles are so attached to the eye that torsion results almost without exception when any one muscle contracts, particularly when the eye is in a secondary position. For example, when the eye is turned upward, innervation of the internal rectus would tend to produce excyclotorsion, while continued innervation of the superior rectus would tend to cause increasing encyclotorsion as the eye is turned toward the nose.

Listing's law gives evidence of the degree of total muscular coordination normally existing so far as cyclotorsion is concerned. All the data presented (Landolt, and others), show a strange overriding of this normal muscle balance. This could come about as an inhibition of some of the muscles tending to produce encyclophoria, or an increased innervation of some other muscles tending to increase excyclophoria.

The idea of increased inhibition to certain muscles during convergence is not tenable since it implies an overall excess of muscle activity which would be considered abnormal, and it has already been demonstrated that inhibition occurs automatically in one of a pair of antagonistic extraocular muscles during an eye movement.[8] The possibility of increased activity of some muscle, then, seems to be more likely.

The inferior obliques seem to be the only muscles which could be so involved for two reasons. First, they tend to produce excyclophoria: and second, they are innervated from the third nerve nucleus the same as the internal recti. It is well known that the activity in the third nerve nucleus associates the innervation for convergence, accommoda-

tion, and pupil size. It is conceivable therefore that the inferior oblique innervation also could be associated neurologically with convergence. Furthermore the efficiency of the inferior oblique in producing torsion is greatest when the lines of sight are elevated, and least when they are depressed. This is in good agreement with the observation that increased excyclophoria occurs when the lines of sight of the eyes are converged and elevated, while excyclophoria is least when the eyes are converged and depressed.

PRACTICAL IMPLICATIONS

The fact that cyclophoria of appreciable magnitude stems from convergence movements in all but elevation position makes it of importance in steropsis situations involving targets separated vertically, in measurements of meridional aniseikonia and certainly in the specification of cyclophoria itself.

Further significance in the field of every day vision stems from the fact that, due to these cyclophoria changes, the horopter has to be defined for every position of elevation and convergence. In only one position can the horopter lie in a surface at right angles to the line of sight. This effect is suggested in every day life by the unconscious tilting of the reading page away at the top. In a lowered-converged position the page must be nearly at right angles to the line of sight, whereas in an upward-converged position the page must be tilted, top away, to properly satisfy the horopter conditions and the feeling of comfort. If a person is forced to work on material that cannot be tilted to match his cyclophoria condition, discomfort may result. This can be demonstrated by reading a few paragraphs with the book tilted toward you at the top and held reasonably close (40 cm. or less).

In those occupations, for example, where the material fixated is vertical, at or above eye level and near at hand, a serious cyclophoria handicap is induced. It is suggested, therefore, that attention be given to this factor in taking optometric case histories and, that in the case of industrial or human engineering studies, it be considered in the design of equipment and machinery requiring vision for their operation.

CONCLUSIONS

1. Cyclophoria is always associated with convergence except at a position of depression of around 30-35°.

2. Cyclophoria values as high as 16° at extreme positions of elevation and convergence may be obtained.

3. Cyclophoria data obtained by one system of axes can be converted to some other system by mathematical treatment.

4. The system of axes used to obtain any cyclophoria data must

be specified, otherwise much of the value of the data is lost.

5. The tilt forward or backward of the horopter cannot be meaningfully specified unless the elevation and convergence are also specified.

6. Cyclophoria with convergence cannot be explained by Listing's law, but the effect of Listing's law is undoubtedly additive to or subtractive from the convergence component in the cyclophoria data.

7. That the cyclophoria associated with convergence is different from that predicted by Listing's law may be a result of the possible neurological involvement of the inferior oblique in the same way that accommodation and pupil constriction are associated with convergence. All are innervated through the third nerve nucleus.

8. Cyclophoria associated with convergence can be an important factor in the measurement of meridional aniseikonia and in the location of the axis of astigmatism.

9. Special consideration should be given to this problem in taking ocular case histories, in the eye examination, in testing procedures, in occupational vision cases, in the design of test and other equipment requiring vision, and in the visual problems of industry.

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THE RESULTS OF PRESCRIBING VERTICAL PRISMS FROM THE TURVILLE TEST*

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The detection and measurement of hyperphoria has never been a great clinical problem. Emsley[1] classifies the clinical tests for hyperphoria in the following categories: (1) Exclusion or cover tests, (2) Diplopia or displacement tests, (3) Distortion tests, (4) Tests with independent objects. Representative tests in each of the four categories which have common clinical usage are: the objective and subjective cover tests, the prism displacement test of von Graefe, the Maddox rod test, and tests with Brewster stereoscopes. All tests in the first three categories prevent any fusion from occurring. Some tests in the fourth category allow some of the visual field to be seen binocularly; that is, fused. The test used on the patients reported in this paper is in that category.

Each refractionist uses one or more of these clinical tests to detect and measure heterophoria and most refractionists have confidence in the test's reliability and validity. When the refractionist writes the prescription, he often has to resort to a rule of thumb or pure intuition in order to decide how much vertical prism, if any, should be prescribed. Maddox[2] advised prescribing vertical prism to correct about two-thirds of the vertical deviation. He advised taking into account the fact that the physiological effect of a prism is greater for far vision than for near vision. Giles[3] advises correcting three-fourths of the amount of vertical heterophoria as disclosed at the near point. Emsley[1] recommends prescribing the refractive correction alone and if symptoms persist to prescribe a prism to correct two-thirds, or the full amount, of the deviation. Duke-Elder[4] advises prescribing for the hyperphoria disclosed, less perhaps ½ diopter. Borish[5] advises correcting the full amount of the deviation if such a correction balances the vertical vergences. He states that when the recovery points of vertical divergence agree with the manifest deviation, the prism is most readily accepted. The authorities cited above do not advise correcting hyperphoria of less than one diopter. Bielschowsky[6] advised looking for a cause other than hyper-

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phoria to explain the symptoms if the deviation is not higher than one arc degree (1.75 diopters). He also advised testing repeatedly on more than one visit and testing in positions other than the primary one.

Tait[9] advises prescribing the amount of vertical prism which requires the patient to use only one-fifth of his vertical fusional amplitude to oppose the deviation. Scobee[10] recommended a technique developed by Bennett and Thompson.[11] This technique consists of determining the horizontal fusional amplitudes when the targets of a major amblyoscope are set for a series of different vertical divergences. The prism is prescribed that gives the maximum horizontal fusional amplitude.

Morgan[7] prescribed the full amount of vertical deviation disclosed in the Turville Infinity Binocular Balance Test in 32 of a series of 215 patients. All of these patients who wore vertical prism were not seen later to determine if the hyperphoria had been influenced by the wearing of the prism. The criterion of the success of the prescription was the ocular comfort of the patient. Morgan[8] was later of the same belief that the amount of prism that levels the two monocularly seen halves of the field should be prescribed. He advised an investigation of the vertical deviation in the cardinal directions of gaze and a modification of the amount of prism prescribed if the hyperphoria is non-concomitant.

The patients whose data are reported in this paper were selected from the patients in a private optometric practice. All patients who fulfilled the following bases of selection were included in the group reported in this paper. The bases of selection were: single simultaneous binocular vision, nearly constant wear of the lenses prescribed at the time of the last refraction, a vertical deviation of one prism-diopter or more as determined by the Turville technique, and the return of each patient for a progress report after wearing his new correction for at least 3½ weeks. Vertical prism for distance vision was prescribed by one criterion alone: the amount of prism required to keep the two test objects level for a time that varied roughly from four to six minutes. Static skiametry, a monocular subjective refraction of each eye, and heterphoria tests at distance were made before the Turville test was used to determine the amount of vertical prism to prescribe. It is believed that the technique and order of these tests influence the critical test for vertical prism; therefore, they will be described in detail.

A case history was taken. The visual acuity was recorded for each eye with and without the patient's distance correction. An objective and subjective cover test was made. If the case history, the cover test or the patient's correction indicated that a vertical deviation might be subsequently disclosed, the vertical balance was determined through the

patient's distance lenses. The frames or mountings were leveled and adjusted. The Turville septum was lowered into place and the distance test objects were leveled by the use of trial-case prisms. The patients lenses were removed and his head was correctly positioned behind an accurately leveled refractor. Static skiametry was performed. The subjective refraction of each eye was determined monocularly. A 32 mm. round white spot was projected on the screen. A white Maddox rod, axis vertical, and a Risley prism were placed before the unoccluded eye. The rod was covered by a card and the other eye was uncovered. The card was removed briefly and the patient reported the position of the streak with reference to the round light. The Risley prism was adjusted while the rod was covered until the patient reported the streak seen through the Maddox rods as centered on the spot. The Risley prism and Maddox rod were rotated through 90 degrees and the identical procedure was followed to determine the hyperphoria. The prism was left in place and the Maddox rod was swung out of position. The two green spots of American Optical Co. Project-o-chart slide #1215-W were exposed and a dull gray septum 4.75 cm. wide and at a distance from the patient of 140 cm. was lowered into position. The size and position of the septum allowed each eye to see only the ipsilateral spot. Both eyes saw the projection screen and the rest of the refracting room within the limits of the apertures of the refractor. The patient was asked to judge which of the two spots was higher. The spots were leveled by Risley prisms calibrated in 1 diopter steps and the readings were recorded to the nearest ½ diopter.*

The final determination of the state of refraction was made while the leveling prism was in place. It was often necessary to make repeated adjustments of the prism to keep the two half-fields level as the final subjective refraction was determined. The vertical prism was recorded to the nearest ½ diopter and prescribed in the distance correction.

During static skiametry normal binocular vision was interrupted by keeping the refractionist's head between one eye and the distance fixation target. Dynamic skiametry was performed after the subjective refraction and heterphoria tests. By following this procedure binocular vision was completely interrupted for a period that varied from ten to twenty minutes before the vertical deviation was determined by the Turville test.

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*The test distance was 640 cm. and spots were 32 mm. in diameter with a separation of 12.7 cm. from center to center. With such a configuration, the introduction of ½ diopter of vertical prism before one eye jumps the spot one spot diameter. Such a vertical displacement of one spot inclines a line passing through the centers of the spots 14.1 degrees from the horizontal.

Each patient in this study returned for a progress report at a time that ranged from 4 to 27 weeks. The mean elapsed time was 6.6 weeks and the median elapsed time was 6.3 weeks. At the progress report the patient's lenses were adjusted so that the line of sight passed through the pole of each lens when the patient's head was in its normal position for distance vision. The two green spots were exposed, the septum was lowered into position and the patient was asked to judge which spot was higher. If they were judged level, a ½ diopter trial case prism was placed base-down before one eye and then the other to see if the patient reported the jump and to see if the displaced spot remained higher. If the displaced spot returned to a level position, prisms of greater strength were added until the images did not remain level. The prism was placed in both the base-up and base-down positions to rule out the possibility that the patient was rapidly adapting to its effect. The power of the prism that leveled the spot was recorded as the increase in the hyperphoria at the progress report. If a ½ diopter prism, in each position, kept one spot higher and lower for as long as ½ minute, the increase in hyperphoria was recorded as zero.

At the progress report 29 patients required less than ½ diopter of vertical prism to level the test objects; nine required ½ prism diopter, one required 1 prism diopter, and one required 2 prism diopters. None of the patients reported symptoms that were attributed to the correction of the hyperphoria by this technique. None of the patients who were discovered to be undercorrected at the progress report reported symptoms attributed to the under-correction of the hyperphoria. The patient who required an additional 1 prism diopter at the progress report to fully correct his hyperphoria was quite comfortable with his existing condition. This is probably explained by the fact that at both the initial refraction and at the progress report his hyperphoria decreased 1 prism diopter at the reading level. The five diopters of vertical prism fully corrected his hyperphoria for distance but over corrected it for near vision. At the end of six weeks, his hyperphoria was fully corrected at near and under-corrected at far by 1 prism diopter. The amount of prism in his lenses was not changed. The hyperphoria of the patient who required two diopters additional prism at the progress report changed similarly at near. Her problem was further complicated by the fact that she had recently been stricken by a cerebral hemorrhage.

The rate of change of hyperphoria was computed for each patient for two periods. The first period was the time from the patient's previous refraction to the present one. In this first period, there were 32 changes of vertical prism in the prescription. Four changes were de-

creases and 28 were increases. The net mean rate of increase was 0.32 prism diopters per year. (Twenty-seven of this group of 32 patients had been previously refracted and the same criterion had been used to prescribe vertical prism. For these 27 patients, the period between these two refractions ranged from 12 to 56 months.) The second period was the time between the refraction and the progress report. In this period there were nine increases of ½ prism diopter, one of one prism diopter and one of two prism diopters. The mean rate of increase was 1.5 prism diopters per year. If the data of the 70 year old patient who suffered the vascular accident is eliminated from the series, the rates for the two periods are 0.31 prism diopters per year and 1.1 prism diopters per year. The mean rate of change of hyperphoria at the last refraction and at the progress report was computed for the group of 27 patients who had prism prescribed by the same technique at a previous refraction. For this group, in the period from refraction to refraction there were 16 increases, three decreases and a net mean rate of change of 0.25 prism diopters per year. In the period from refraction to progress report there were six increases for a net mean rate of change of 1.0 prism diopters per year. In each case the rate of change in the second period was roughly four times the rate of change in the first period.

There has been considerable discussion in the literature as to whether the wearing of vertical prism causes an increase in hyperphoria. Ogle and Prangen[12] have recently shown that some subjects who have worn lenses to reduce a vertical fixation disparity to zero return a month later to show a nearly complete compensation for the prism. They also report subjects who have compensated for six diopters of vertical prism to the extent that the vertical fixation disparity and the vertical vergences returned to the original level in less than an hour of wearing a prism to force the vertical divergence. To explain these results they assume two components of the compulsion-to-fusion reflex. One component operates in the fixation of oblique points and in fixation through anisometropic lenses. It is a psycho-optic reflex and is voluntary. The second component is involuntary and has two aspects: a rapid one and a slow one. The first comes into play in clinical vergence tests and has limits of about three diopters. The second one operates in the compensation to prolonged vertical divergences and has limits in excess of six prism diopters. Ellerbrock[13] also found that vertical divergence responses of six prism diopters could be achieved if the stimulus was in effect for two to three minutes. Ellerbrock[14] and Ellerbrock and Fry[15] investigated the compensation that anisometropes make in order to maintain a constant hyperphoria in all fields of fixation. Most anisometropes maintained the same vertical heterophoria in the hori-

zontal plane and at the reading level. The compensation was such that the mid-point of the range of vertical divergence shifted with the change of hyperphoria. Twenty-one out of 50 of Ellerbrock's subjects who were given anisometropic prescriptions both with and without a compensating slab-off prism could tell no difference in the two prescriptions.

Three-fourths of the patients in this series showed no increase in hyperphoria after wearing vertical prism to fully correct the deviation disclosed by the Turville technique. One-fourth of the patients required ½ diopter of vertical prism to fully correct the vertical deviation. Only two patients required one or more prism diopters to fully correct the vertical deviation. Each of these patients had a deviation that decreased at the reading level and this deviation was fully corrected by the original prism. In as much as the mean rate of increase of the group after wearing the prism was greater than the mean rate of increase before wearing the prism, the data reported in this paper do show that the vertical deviation of some of the subjects was increased by wearing the prism correction. However, the difference was slight and the increase in prism was not clinically significant. These different reactions of the patients of this series can be explained in two ways: a latent hyperphoria that was present at the initial refraction was made manifest at the progress report due to the wearing of the prism, or there are two different responses of the visual neuro-muscular system to the wearing of the vertical prism and one response is to accept it fully, the other to slowly compensate for it. The data herein reported does not yield a definite answer to this question.

These data do show that the vertical prism that levels the paracentral fields that are seen uniocularly when a Turville septum is used in a routine refraction can be incorporated in the distance lens correction.

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BOOK REVIEW

CLINICAL ORTHOPTIC PROCEDURE. Second edition. William Smith, O.D., F.A.A.O. Published by the C. V. Mosby Company, St. Louis, Missouri. 524 pages. 91 illustrations. Cloth. $10. 1954.

The appearance of a second edition of this book four years after the first is ample proof of its popularity. The text is ambitious in scope, covering etiology and treatment for most of the neuromuscular anomalies. The Glossary of Terms, Bibliography, and Index add to its usefulness, as do the illustrations, many of them of visual training equipment. The generous use of case histories increases the usefulness of the book and makes for greater clarity.

The one major weakness of the book lies in the classification of defects, and many optometrists will find much here with which to disagree. For example, such terms as "convergence insufficiency" are not used, anomalies of this type being discussed under the heading of "exophoria." The author's statements like "Base-out is the specific orthoptic treatment for ordinary, uncomplicated exophorias after optical correction is made" (p. 179) leave much to be desired in the light of clinical methods in which the phoria is considered in relation to ductions. In spite of these shortcomings, however, the book will have value to any practising optometrist, if for no other reason than to make him cognizant of the present broad scope of orthoptics.

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GILES TALKS FOCUS ATTENTION ON NEED FOR HEALTH PLANNING.

The recent visit of George H. Giles to the United States and Canada has revived the discussions of public health plans among optometrists. Giles, a leading figure in British optometry, did more than any other optometrist in the British Isles to chart the course of the profession in the transition from private practice to its present place under a program of socialized health care.

Giles is a foremost British authority on orthoptics and he had planned to lecture on squint and orthoptic procedures while in America. This, of course, he did and his audiences appreciated his lectures immensely and profited greatly by them.

However, wherever he went he was called upon to discuss the British Health Scheme, and the part optometrists played under this

national program of health care. Giles did not come to these shores to promote this or any other health program. Yet, he is so strongly identified with optometric participation in this program that his audiences wanted to hear a first hand account of his experiences and his future hopes under this program.

Here, too, Giles was no disappointment. He presented the facts as they were and are—the good and the bad—and he made optometrists realize the inevitability of changing times and conditions. He made us feel, too, that British optometry, despite the hardships of the readjustment period, could serve and prosper under a Scheme of this sort.

All in all, his visit was a grand thing for the many students, optometrists and faculty people who were privileged to hear him. He spoke at many of our schools and colleges and the lecture halls were always filled to overflowing. He made us feel more than ever before that British optometry is a live dynamic force for good in the world and he also made us aware of the pressing need for more careful study and planning of our own course of action should we face similar federal national health proposals in America in the future.

CAREL C. KOCH

PROGRESS MADE BY NATIONAL BOARD

The National Board of Examiners in Optometry has now concluded its third year. During the first year it conducted Part I of its examination. This portion is given to the candidates at the end of their Junior college year. Part I consists of examining candidates in ocular anatomy, general physiology, ocular physiology, theoretical optics, geometrical optics, physical optics and the underlying sciences dealing with vision.

In the Board's second and third years, in addition to Part I of the examination, Part II and Part III were held. These parts were given candidates at the end of their Senior college year. Part II consists of examining candidates in physiological optics, the theory and methods used in the practice of optometry, ocular pathology and related subjects taught in the Senior year of undergraduate optometry professional training, and Part III consists of examining candidates in all of the clinical and professional skills and judgment required of an optometrist. Part III is a comprehensive clinical and practical examination.

These National Board examinations are held annually. The tests are conducted simultaneously at all schools and colleges throughout the country. These examinations are monitored by faculty and State Board of Examiner personnel especially selected for this purpose.

The examination techniques and papers are prepared by members of the National Board of Examiners in collaboration with members of the Association of Schools and Colleges of Optometry. The three part examination is believed to be the most comprehensive series of tests ever presented to optometric candidates, and during the first three years more than 350 new graduate optometrists have passed all three parts of the examination. All of these candidates received their degrees in optometry since 1952.

Now just what is the future and purpose of this immense undertaking? Some fear that this may replace the present work of State Boards of Examiners in Optometry. Others believe that in time this may create a national reciprocity scheme. Some seem to feel that it is an attempt to license optometrists at the national instead of the State level. The answer to these fears is an emphatic "no," as the National Board contemplates none of these things.

Each State Board of Examiners, as an agent of the State, has its own specific function to safeguard the visual health of its citizens. This regulatory licensure procedure cannot be assigned or abridged to a National Board, nor has this ever been suggested.

The National Board may, however, augment the work of individual cooperating State Boards and materially assist them in their duties and examining activities. When used by State Boards the findings of the comprehensive three-part examination of the National Board are of great value as they give the State Boards a standard and effective check of the applicant's understanding of optometric science and clinical procedures. The National Board tests, prepared and administered by eminent educators and representatives of the I.B.B., assure State Board members of examinations of very high calibre administered by men of unquestioned integrity.

Under the proposed arrangement, the individual State Board remains in full control, but substitutes the National Board certificate and examination grades for portions of its own examination. In fact, several State Boards are now utilizing this examination procedure for those applicants who are Diplomates of the National Board. In these States, the State Board of Examiners, in addition to using the findings of the three-part National Board examination, thoroughly examines the Diplomate in, practice procedure, ethics, optometric economics, dispensing, the sociology of health care as it applies to vision and similar subjects. It is not until this final examination is passed by the applicant that he receives his license to practice optometry from the State Board to which the applicant applies.

Is the National Board of Examiners in Optometry expected to promote a national program of reciprocity? Not at all—such a program could only come into being through wide spread demand on the part of optometrists themselves, and this would probably require changes in many existing optometry laws.

Does the National Board of Examiners in Optometry ever hope to license optometrists at the National level? Again the answer is *no*, and the reason[1] is found in the principle referred to as "States Rights." According to "Article X of the Bill of Rights, United States Constitution, the powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people." The power of licensure of the various professions is not delegated to the United States by the Constitution, therefore, it is reserved to the States.

From the foregoing, it should be clear that the National Board of Examiners in Optometry is not a rival examining body competing with State Boards. On the contrary, the National Board augments and complements these Boards and when used properly by them makes their work more accurate and much simpler to perform properly.

It should also be clear that the National Board itself is a creature of the State Boards, having been created by the I.B.B. in 1951, and its members are appointed by the I.B.B. in collaboration with the Associations of Schools and Colleges of Optometry. The present officers and members of the National Board of Examiners are, President, Rudolph Ehrenberg, O.D.; Vice President, Bruce Jaques, O.D.; Secretary-Treasurer, John R. Uglum, O.D.; Richard Feinberg, O.D., Ph.D.; Harold M. Fisher, O.D.; Henry W. Hofstetter, O.D., Ph.D., and J. D. Rust, O.D.

The writer is pleased to report that the work of the National Board is off to a splendid start, and at this time we of the National Board urge the profession and the State Board members everywhere to continue to give strong support to this progressive step in licensing procedure.

RUDOLPH EHRENBERG

[1]Carel C. Koch. National Registration and Reciprocity. Am. J. Optom. and Arch. Am. Acad. Optom. 22.2. 85-90. 1945.

SPECIAL REPORT

THE CHANGING ATTITUDE TOWARDS THE BLIND AND THE PARTIALLY SIGHTED*

Joseph I. Pascal†
New York, New York

Even yet we come across the statement that a blind man is a dead man, though perhaps not so often now as in previous years. In line with the above is the belief, still widely held, that a person with *very poor vision*, 20/200 or less, is half dead. Officially such a person is classified as blind. Total blindness is generally rated by insurance companies and compensation boards as total disability; thus if not exactly "dead" the individual is considered very close to it.

THE NEW ATTITUDE

The above attitude about the blind and the partially sighted is wrong. A new attitude which for some years has been replacing it postulates that the blind and the partially sighted suffer from a handicap which, in most cases is compatible with a useful and satisfying life. In fact, a blind man may be far more alive than many a man with two perfect eyes.

THE BLIND AND THE PARTIALLY SIGHTED

We must make a distinction between the two groups from a standpoint quite different from the legal definition of blindness. In this discussion blindness refers to a condition of total blindness, or at most to a qualitative degree of vision limited to light perception. However, those individuals who have some form vision, can count fingers at near, or have a Snellen acuity of even one per cent, may be termed partially sighted. It is immediately apparent how different this concept is from the legal definition of blindness. According to that definition a person having a Snellen acuity with the best possible ametropic correction of 20/200 or less is legally blind. According to our more modern concept a Snellen acuity of 20/200 which is an V. A. of 10 per cent places the individual in an advanced position in the category of the partially sighted.

*Read before the annual meeting of the American Academy of Optometry, Chicago, Illinois, December 5, 1953. For publication in the June, 1954, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

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REHABILITATION OF THE BLIND

It is now established that the totally blind, if they have the will and the perseverance, can be rehabilitated to a large extent. They can learn to fit themselves into the social and economic framework of society. There are numerous instances of blind individuals who have achieved far more than many full-sighted persons. Aside from such outstanding figures as Miss Helen Keller and the late U. S. Senator Thomas B. Gore, there are many totally blind individuals who have achieved a position in life far above that of the average full-sighted individual.

A recent newspaper item, NEW YORK TIMES, May 31, 1953, showed a picture of a 24-year-old man, Joseph Giovanelli, totally blind, who is self-supporting. Not only this, but he has several fields of recreation and activity: he is a fair pianist and repairs radios and other electronic gear. In fact, he holds a first class radio license. Giovanelli claims, "Blindness is no handicap, but an inconvenience."

Some of these rehabilitated individuals effected their rehabilitation by themselves with the aid of family and friends, but without institutional guidance. Most of them, however, had the guidance of special institutions equipped for that purpose. This rehabilitation of the blind is in line with the trend for the rehabilitation of *all* physically handicapped persons. The emphasis in all cases is not on what is lost but on the faculties that are retained. And practically all cases where there was *the will to succeed*, the individuals, after being trained so as to utilize fully the faculties and abilities which they had, were enabled to lead a useful and satisfying life, in spite of the handicap of blindness. It is probably more correct to say that they succeed not in spite of their handicaps, but because of certain positive qualities which they possessed. No one is complete in every respect. Everyone has some handicap.

ROLE OF THE OPTOMETRIST

The professional skill of the optometrist does not directly come into play in the rehabilitation of the totally blind. However, the optometrist should be well informed on the subject. As a vision specialist he is apt to be consulted by those who are blind or who fear total blindness. He should be able to comfort them, cite instances of the totally blind who have achieved success in one field or another. He should have a list of the various institutions catering to the blind, know the extent of their rehabilitation and other services, and also know something of their mode of operation. It would be a professionally nice gesture for the optometrist to interest himself actively in the work of the various institutions for the rehabilitation of the blind.

VISUAL REHABILITATION OF THE PARTIALLY SIGHTED

At the outset it was emphasized that the partially sighted should

not be lumped into one group with the totally blind. There must be a distinct separation of the two groups. Visual rehabilitation of the partially sighted differs markedly from rehabilitation of the blind.

Visual rehabilitation of the partially sighted is an expanding field of service, areas of which are still not fully explored. Dr. Gabriel Farrell, director of Perkins Institution, says, "In the whole area of the visually handicapped, the partially seeing far outnumber the blind, but while their needs are great, interest in them is very meager."

ORGANIZATIONS FOR THE BLIND

There are some 800 organizations for the blind, which term includes the totally blind and the partially sighted, according to the still prevalent manner of lumping them together. These offer many types of services. But there is not one organization devoted solely to the visual rehabilitation of the partially sighted. It has been well said, that: "A man is not blind if he can read with the use of his eyes, no matter what device he uses to help himself." Visual rehabilitation will enable at least the majority of the partially sighted to read with their eyes.

Col. E. A. Baker, managing director of the Canadian National Institute for the Blind, says that, in Canada at least, "it is estimated that for every registered blind person there are ten in the group of 6/60 to 6/18, and since a substantial portion of these are experiencing difficulty in the ordinary labor market—the Canadian National Institute for the Blind is undertaking a special placement service for the partially sighted group. . . ." What a potential field is here presented for visual rehabilitation!

Moreover, in line with the legal definition of blindness as being vision of 20/200 or less, is the generally inadequate definition of partial sight. This is said to be vision between a Snellen acuity of 20/70 to 20/200. But this is much too narrow a definition. Some persons with a Snellen acuity of 20/1000, when supplied with the proper visual aids, have been enabled to obtain a regular education and qualify as useful, self-sustaining members of the community.

SEPARATING THE PARTIALLY SIGHTED FROM THE BLIND

The first attempts to separate these two groups were made with children more than 150 years ago. In 1802 Franz von Gaheim in Austria pleaded with the authorities to provide separate classes for the partially sighted children. He showed that placing them in the same classes with the totally blind was injurious to both groups. Still it was not until more than 100 years later that the first school for partially sighted children was established in London. The first medical director of the London School Board, Dr. James Kerr, called upon a number of young doctors to make an investigation of the vision of school children.

Among those selected to work on the problem was N. Bishop Harman who later became a noted ophthalmologist. In 1902 he was placed in charge of the ophthalmological services of the London Schools for the blind. He soon discovered that many of the children were not blind but were high myopes. As a result of his efforts the first school for the partially sighted was opened in 1908. Harman called this the Myope School, and it was the forerunner of the sight saving classes for the partially sighted all over the world. In 1911, a similar school for partially sighted children was established in Strassburg, Germany.

In 1909 Dr. Edward B. Allen then director of the Perkins Institute in Boston, who had learned of the Myope School in London, began to agitate for the organization of such a school and finally succeeded in interesting the Boston School Committee. As a result of his efforts the first class in the United States for partially sighted children was opened in Roxbury, a suburb of Boston in 1913. This school was not exclusively for myopes, its scope having been widened "to meet the needs of children having any serious eye difficulties that interfere with educational progress." The classes were in a separate building and the partially sighted were separated from the blind children as well as from the normally seeing children.

Shortly thereafter Dr. Robert B. Irwin organized similar classes for the partially sighted children in Cleveland. He used what came to be known as the "cooperative method," the partially sighted children carrying on as many activities as possible with the normally sighted children. This seems to be a better method than that of segregation, since the latter carries a stigma which has an unfavorable psychological effect on the children and may leave permanent psychological scars.

It has been found that partially sighted children and fully sighted children can carry on in the same class for most of their work. Now and then the partially sighted children may go to a special class. Moreover, utilizing this procedure of visual rehabilitation enables partially sighted children to work more effectively with the fully sighted children. The Committee on the Education of the Partially Seeing Children of the National Society for the Prevention of Blindness strongly recommends the cooperative method.

At present both the segregation and the cooperative method are in use, some schools employing the Boston method, that of segregation, and others employing the Cleveland method. There are now over 700 special classes for the partially sighted in over 225 cities and counties, in 31 states. Unfortunately, however, the vast majority of partially sighted children whose Snellen Acuity classifies them as legally blind, are still being taught with the totally blind. Another field for the op-

tometrist consists of restoring to these children the ability to utilize whatever sight they have to the fullest extent.

A GLARING INSTANCE OF CONFUSION

Dr. Paul A. Zahl in his book on Blindness lists the contributing writers to the volume. He placed an asterisk against the names of those authors who are blind. I know, personally, one of the authors labelled blind, Peter J. Salmon, executive director of the Industrial Home for the Blind in Brooklyn, N. Y. He is legally blind, his vision being about 15/200. But with telescopic lenses he was able to see a ball game for the first time, and with the addition of a reading cap he reads "without discomfort, newspapers, magazines and in fact anything that one would be apt to read."

Doubtless some of the authors listed by Zahl as blind are totally blind, but most likely some of the others so listed, with proper visual rehabilitation, can obtain as effective and useful vision as Mr. Salmon has.

There is no single agency, national in scope, devoted to the sole purpose of *visually* rehabilitating those who still have some vision. Probably half of these classified as blind are partially sighted, and most likely the majority of these could be visually rehabilitated even "to avoid the appearance of being blind," to use the words of Dr. Gabriel Farrell.

THE PARTIALLY SIGHTED

It is estimated that there are 300,000 individuals who although legally blind have some degree of form vision. A large number of these people are in institutions for the blind, where they are treated like the totally blind. They *must be separated from the totally blind and treated differently.* This is the *optometrist's great opportunity.* He is not directly concerned with rehabilitation of the totally blind, but he is vitally concerned with the *visual rehabilitation of the partially sighted.* This is within the scope of optometry.

CENTERS FOR VISUAL REHABILITATION

The need today is to organize centers for the visual rehabilitation of the partially sighted. Such centers should be staffed by ophthalmologists, optometrists, educators, psychologists, illuminating engineers, and others, all working together for a common purpose. I would suggest that the Academy appoint a Committee on Visual Rehabilitation of the Partially Sighted.

SUMMARY

The old attitude that a blind man is a dead man is giving way to the new attitude that the blind with determination can learn to lead a

useful and satisfying life. But even more important is the new attitude towards the partially sighted. These have always been thrown together with the totally blind to the detriment of both. It is known that the partially sighted, when supplied with the newest forms of visual aids, in the majority of instances can become fully rehabilitated. A brief historical outline is given of the origins of the organized schools for the partially sighted children. The two types of schools now existing are reviewed and the superiority of the cooperative method emphasized. A plea is made for the organization of an Institute for the Visual Rehabilitation of the Partially Sighted.

ON THE INSURABILITY OF VISION CARE*

Joseph Ziff†
Los Angeles, California

As a result of a resolution passed at the 1954 convention of the California Optometric Association, a committee was formed to negotiate with insurance companies to get them to incorporate "vision-services" in group and other health insurance policies. It was realized that it would be necessary to create a demand for these services on the part of the public. The prospects that this can be accomplished are most hopeful.

The writer is, therefore, disturbed by the treatment this subject received from Hirsch[1] in the April issue of the AMERICAN JOURNAL OF OPTOMETRY. We believe the views presented by him should be answered.

To be sure, until recently, the opinion of many optometrists was that vision care was not an insurable entity. This view was held, we believe, regarding the idea of insuring optometric care as a unit, all by itself. There was confusion, too, in comparing the position of optometry and vision care with that of dentistry.

Vision services, we are certain, can be insured as a part of a group health program on a basis of part payment of a benefit on the same level as these benefits now exist for other health services. They are probably not insurable as a total benefit, first: because of the wide,

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†Optometrist. Fellow, American Academy of Optometry.
[1]Monroe J. Hirsch. The Non-Insurability of Ocular Refractions. Am. J. Optom. and Arch. Am. Acad. Optom. 31.4. 206-212. 1954.

though not universal need for vision care. Second; because of the re-examination rate recommended for the frequency of vision care, (approximately every two years for adults—oftener for children.) Third; because of the unpredictable diversity of lens prescription costs coupled with the need for lens mountings and desire for various styles in frames.

All of the factors of vision care can readily be adapted to a part payment benefit. This part payment benefit must not be confused with a charge for examination or refraction, but must be regarded simply as a part payment of the total expenditure whatever this is. This is not a new concept at all. In present fee schedules of the open panel type of health insurance it is not uncommon that the insured is told that the doctor's fee is so much, and that the published fee schedule lists a lesser amount.

Interviews with physicians indicate that this practice is understood by the patient and has been readily accepted although recently demands are appearing for the presenting and payment of total fees.

If, in existing policies or in new ones, a part of the cost of optometric services was specified as a benefit, say $15.00 or $20.00 every two years, the additional premium cost per policy would come to only small additional amounts, and the benefit would be used, we believe, by the policyholder because it is available to him. If for no other reason than this, the advantage to society in visual efficiency and safety would give the plan merit.

The additional cost above the insurable benefit to the policy holder for the completed service would be dictated by the nature of the prescription, type of or style of material required, and the need for multiple pairs of glasses. This would remain a transaction between the optometrist and patient and would be no more subject to abuse by the unscrupulous than is now the case.

Maternity benefits have been carried by many insurance companies in their group policies in spite of the restricted use of these benefits. It could not be sold to the public as separate units because the various age groups would react in different ways to such a policy. Maternity benefits are incorporated in group policies because of public demand and though they are probably a loss in themselves, they attract the most profitable age segment of the public as insurance buyers. One can be sure that this is the major motive for its listing. To make a further point, group insurance will accept the heart patient and the ulcer patient even though they would be uninsurable in a policy confined exclusively to heart and ulcer problems.

Automobile insurance policies for collision damage are most often written in a deductible or part benefit clause known as co-insurance. This is the preferred type of coverage advised by underwriters even though the premiums are lower. The reason is that it tends to prevent abuse.

Something should also be said about the recent concern with optometric prepaid vision care. Society has for a number of years foreseen the day when health care by responsible agencies or the government itself would become a reality because of public demand. This demand has grown so steadily that all of the health professions have become involved in one way or another. It has been a great concern of government and will undoubtedly continue to be so since our economic and social problems are becoming more and more complicated. Because of this complication, and the rising costs of health care, larger segments of the public will give ear and voice to appeals for help in either leveling or paying health care costs.

Unless optometry can devise the ways and means of participating in health insurance programs, we believe, it will be in an unenviable position in the health groups. So far as optometric services go, optometry must be able to direct the way this program will go. We must, we believe, influence this policy making to the utmost of our ability, and the time to work on this problem is now.

CURRENT COMMENTS

Terry Judith Parkins
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

CHICAGO COLLEGE CONJOINT PROGRAM

During the past two years the administrative officers of Chicago College of Optometry have arranged with several liberal arts colleges in the Chicago area to start a six year combined curriculum in liberal arts and optometry. This action has the approval of the Board of Trustees of Chicago College of Optometry.

The new combined curriculum does not replace the regular five year undergraduate professional course in optometry at Chicago College. This will continue as usual. The new six year combined curriculum has been especially designed only for those selected students who wish

to make teaching or research their life work. The new six year curriculum is called the "professional option in optometry" and makes it possible for the special undergraduate student to earn a bachelor's degree in the liberal arts or sciences by completing three years in the cooperating liberal arts college and the first two years of the professional curriculum at Chicago College of Optometry. Upon the satisfactory completion of the fifth year of the combined curriculum, the student who has elected the "professional option" will receive his bachelor of arts or science degree from the cooperating liberal arts college. Upon the additional satisfactory completion of the sixth year of the combined curriculum, the student will receive his professional degree, Doctor of Optometry, from Chicago College of Optometry.

During the first three years of study, in the liberal arts college, the student in the conjoint program will be expected to meet the minimum requirements for admission to Chicago College of Optometry, and also to meet the specific requirements for graduation from the liberal arts college in a specified department, exclusive of the work normally required in his senior year in liberal arts.

This conjoint program will enable selected acceptable students to enter any college or university graduate school for advanced academic degrees after completing their work at Chicago College of Optometry. Further information about the conjoint program may be obtained from the Dean, Chicago College of Optometry.

LORD CHARNWOOD RECEIVES RESEARCH MEDAL

His many optometric friends in America will be pleased to learn that Lord Charnwood was the recipient of the Research Medal of the British Optical Association at its general meeting in March of this year. This award was presented to Lord Charnwood for his distinguished work on binocular vision. In addition to his private optometric practice Lord Charnwood is a member of the faculty of the London Refraction Hospital. He is also a Fellow of the American Academy of Optometry. He expects to visit the States and Canada during October.

RUTGERS CONFERENCE ON OCCUPATIONAL VISION

The Third Rutgers Conference on Occupational Vision, November 16, 1954, in New Brunswick, New Jersey, will feature ocular efficiency according to John R. Wittekind, O.D., conference chairman. The problem of industrial seeing conditions and demands, the costs of inefficient vision, the techniques involved in accelerating perception and comprehension, and organizing and maintaining a modern vision program are among the subjects for discussion. Speaking on these topics

will be Glenn A. Fry, O.D., Ph.D., Director of the School of Optometry of The Ohio State University; Henry Hofstetter, O.D., Ph.D., Director of the Division of Optometry, Indiana University; Eugene Freeman, O.D., Ph.D., Dean of the Chicago College of Optometry; and Richard Feinberg, O.D., Ph.D., President of Northern Illinois College of Optometry. Advance registrations may be made with Prof. Maurice A. Chaffee, Director, Rutgers University Extension Division, 77 Hamilton Street, New Brunswick, New Jersey.

LOS ANGELES COLLEGE HONORS TEN

At the Golden Anniversary Banquet of the Los Angeles College of Optometry the following optometrists and educators were honored for their outstanding contributions to the institution. W. S. Cherington, O.D., Los Angeles; William M. Ketchum, O.D., Los Angeles; Ernest A. Hutchinson, O.D., South Pasadena; Harry Fuog, O.D., Los Angeles; J. G. Goodsell, O.D., South Pasadena; Arthur E. Hoare, O.D., Glendale; William M. Kinney, O.D., Brea; Lynn F. Sherman, O.D., Los Angeles; Louis Jaques, O.D., Los Angeles, and Les Scown, O.D., Hollywood. Mr. Paul Yarwood, Executive Secretary of the California Optometric Association served as toastmaster and presented the citations.

CORRESPONDENCE

BACK ISSUES WANTED

To the Editor:

Last year you gave us some very kind and willing assistance in obtaining back issues of the AMERICAN JOURNAL OF OPTOMETRY. We have built up a complete set with the exception of the following issues: Volumes 1-3, all; Volume 4, No. 1-3, 7-9, 11; Volume 5, No. 10, 11; Volume 7, No. 1; Volume 10, No. 4; Volume 13, No. 4, 9; Volume 15, No. 4. We would be grateful to you if you would do whatever you can to help us obtain these issues.*

LAWRENCE HEYL
ASSOCIATE LIBRARIAN

THE LIBRARY
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*The Journal office is unable to supply these missing issues. Princeton University and the Academy would appreciate the gift of any or all of these issues to Princeton University to enable them to complete the sets of this Journal at the Library, Princeton University, Princeton, New Jersey.

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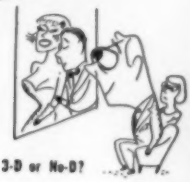

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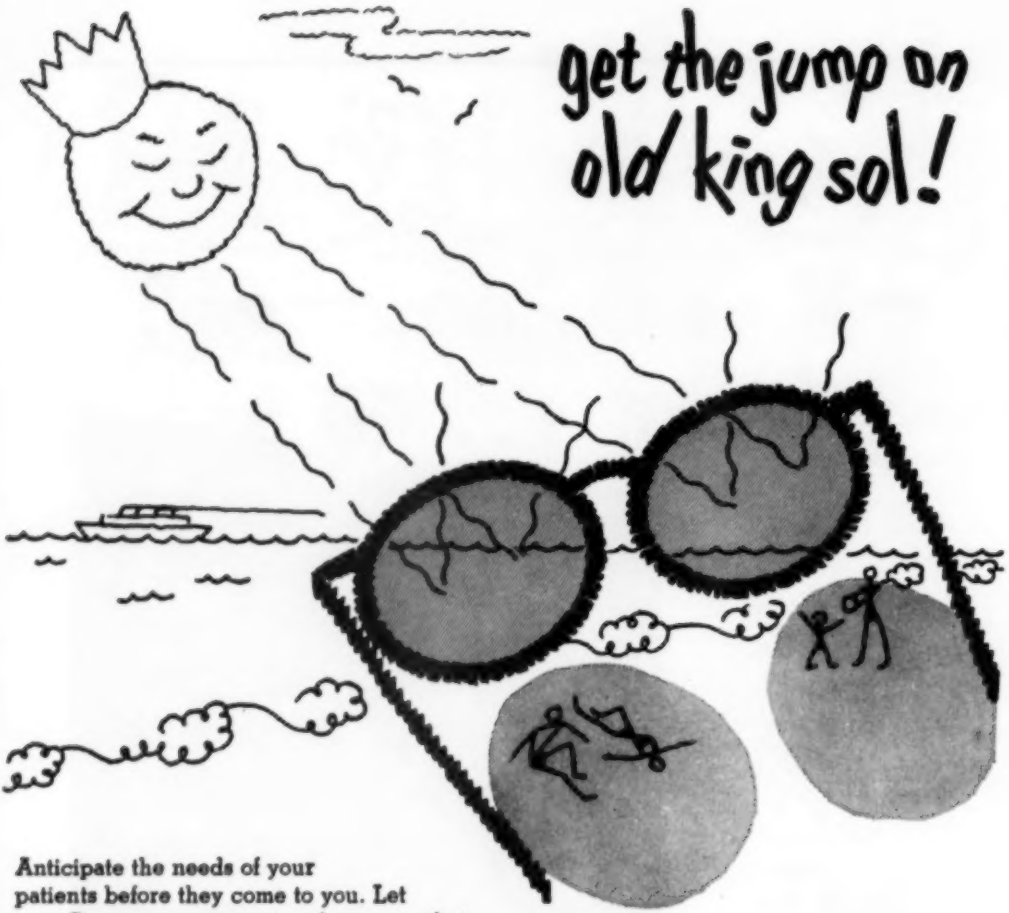

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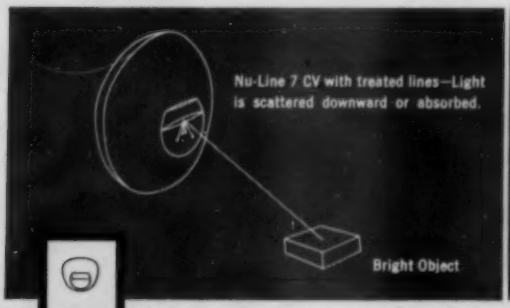

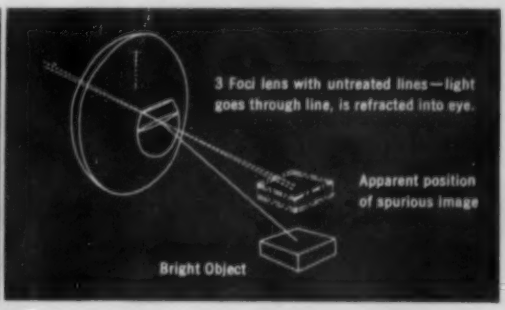
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